The Welding Engineer

Reg. U. S. Pat. Office

Founded by L. B. Mackenzie, 1916

MARCH, 1928 VOL. 13, No. 3

$3.00 per year in U. S. 508 S. Dearborn St., Chicago, Ill. $4.00 per year abroad

New *and* Striking Features *in the* WILSON *Model S Welder!*

INTERESTING *new features* give the Wilson Model S Machine the highest degree of efficiency yet obtained in arc welding equipment. Its carriage is of angle iron construction, welded throughout, and made narrow for easy handling in shops. The improved reactor is mounted over the rear axle to protect it from injury. There are no live parts on the front of the modified control panel. A new rotary switch, together with a new design of field rheostat, afford very fine adjustments of the welding current. Exceedingly close regulation is available for strength welding, while a long arc with heavy current is available for rapid depositing of metal. Close control and quick recovery make the machine ideal for overhead welding, and the standard machine welds the thinnest sheet metal that the electric arc can handle. The Wilson Model S Welding Machines are equipped to give full welding range without extra apparatus or extra cost.

Wilson Model S Welding Machine, one-operator electric-motor-driven Type 200 amperes, welding range 10 to 300 amperes.

One-operator Motor Generator Set	Type 200 Amps.,	welding range	10 to 300 amps.
One-operator " " "	Type 300 Amps.,	" "	15 to 500 amps.
Two-operator " " "	Type 400 Amps.,	" "	10 to 300 amps. or 300 to 600 amps.
Two-operator " " "	Type 600 Amps.,	" "	15 to 500 amps. or 500 to 1000 amps.
One-operator Gasoline Engine Driven	Type 200 Amps.,	" "	10 to 250 amps.
One-operator " " "	Type 200 Amps.,	" "	10 to 300 amps.
One-operator " " "	Type 300 Amps.,	" "	15 to 500 amps.
One-operator Belt Driven	Type 200 Amps.,	" "	10 to 300 amps.
One-operator " "	Type 300 Amps.,	" "	15 to 500 amps.

WILSON WELDER & METALS CO. INC., WILSON BUILDING, HOBOKEN, N. J.

WILSON

WELDING MACHINES AND WELDING WIRE

Published monthly by the Welding Engineer Publishing Co. Entered as second class matter Jan. 20, 1916, at the Post Office at Chicago, Ill. Under the Act of March 3, 1897.

?

Will You Go On Forever Accepting Regulator Troubles?

Do you still consider it necessary to put up with inefficiency and hazard?

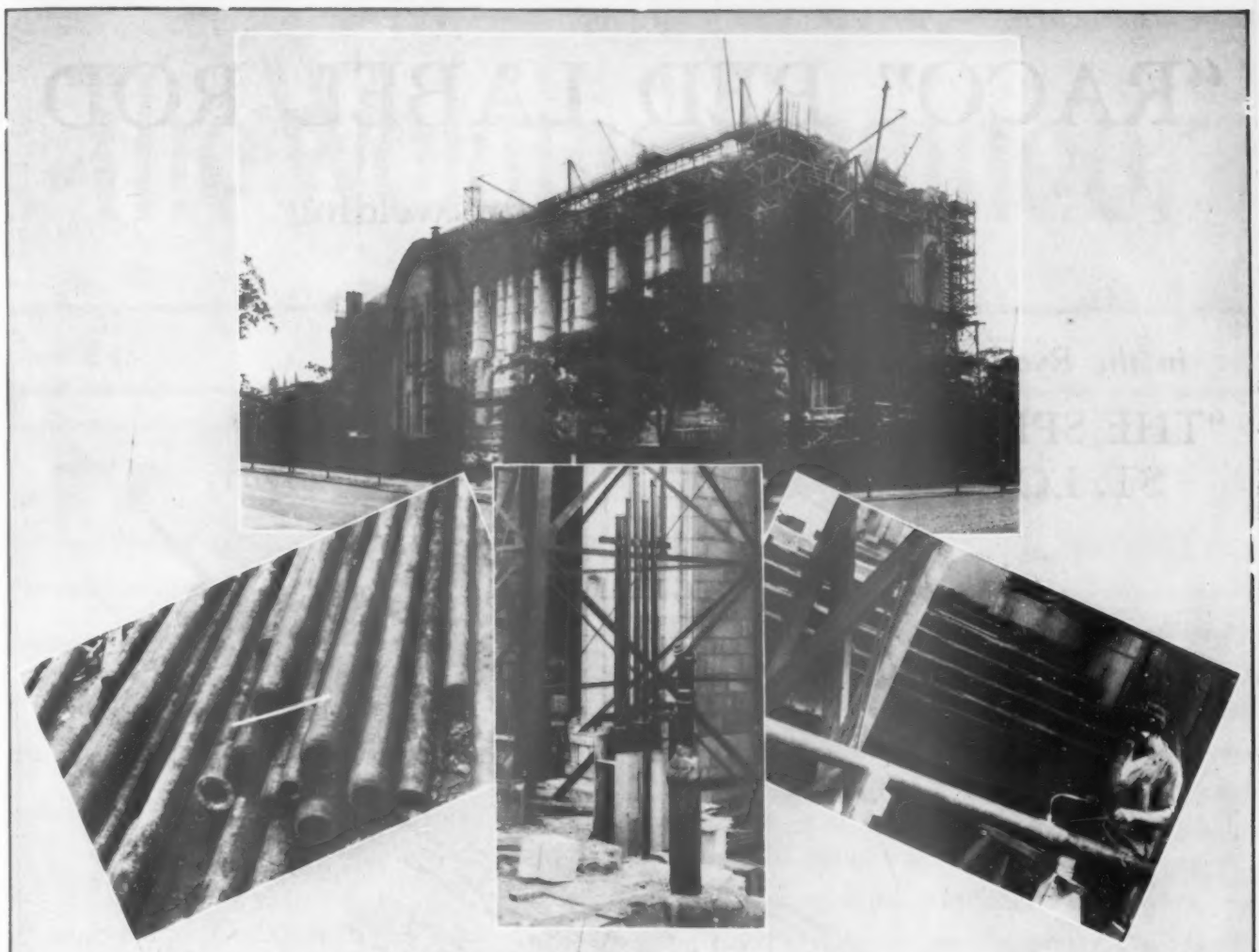
Then let us convince you of the fact that the new VICTOR REGULATOR is a revelation.

It does all of the things other regulators fail to accomplish and has none of the faults you have grown to accept as unavoidable.

VICTOR OXY-ACETYLENE EQUIPMENT CO.

Executive Offices, 844 Folsom St., San Francisco, Calif.

Manufacturers of Fine Welding and Cutting Equipment



*"Welding for Eternity"

THIS TAG IS ON EVERY AIRCO OXYGEN CYLINDER

Buy Your Oxygen On Specification for Purity

AIRCO OXYGEN IS 99.5% PURE IN THE CYLINDER

The Purest Oxygen Is Always the Most Economical

For welding the extra heavy wrought iron steam pipes which are permanently imbedded in the massive walls of the Cathedral of St. John the Divine, New York City, Airco Oxygen and Airco-Davis-Bournonville Welding Torches were used.

This is another expression of confidence in the efficiency and ultimate economy of oxyacetylene welding.

The advice of Airco Engineering Departments on applications of oxyacetylene welding and cutting is available to Airco customers.

*Title of a paper descriptive of this work read before the New York Section, American Welding Society by Mr. A. F. Keogh, Pres. Sound Welding Co., New York, published in the January 1928 Journal of the American Welding Society.

AIR REDUCTION SALES COMPANY

65 Plants — 110 Distributing Points — 21 District Offices

Baltimore, Birmingham, Boston, Buffalo, Charlotte, N. C., Chicago, Cleveland, Dayton, Detroit, Emeryville, Calif., Jersey City, Los Angeles, Milwaukee, Minneapolis, Oklahoma City, Philadelphia, Pittsburgh, Richmond, Seattle, St. Louis, Wheeling

AIRCO — DAVIS-BOURNONVILLE

Home Office—342 Madison Ave., New York City, N. Y.

"RACO" RED LABEL ROD

was used exclusively for welding the steel construction

in the Ryan plane

"THE SPIRIT OF ST. LOUIS"

B. F. MAHONEY AIRCRAFT CORP.
SAN DIEGO, CALIFORNIA
FEBRUARY 15 1928
Reid-Avery Company,
21st & Washington Ave.,
Philadelphia, Pa.
Gentlemen:
Subject: Red Label Welding Rod.
We have been using Red Label welding rod supplied by you for the past year and a half in the construction of our Ryan monoplanes. This rod is used for welding up steel tubing in the fuselage frame, ailerons, tail surfaces and landing gear.
This rod was used exclusively for welding the steel construction in the Ryan plane "The Spirit of St. Louis" which we built for Colonel Lindbergh, and in which he has since flown many thousands of miles with no report of failure in any welded joint.
We take pleasure in stating that your rod has been checked against a number of different makes and has proved to be the best suited for the particular kind of work which we are doing.
Very truly yours,
B. F. MAHONEY AIRCRAFT CORPORATION
(Owners of Ryan Airlines)
Walter O. Locke
Walter O. Locke
Production Engineer
WOL:C

Manufacturers of

OXY-ACETYLENE WELDING RODS

ELECTRIC WELDING RODS

"RACO" COMPOSITE WIRE FOR AUTOMATIC ELECTRIC ARC WELDING

America's Standard

REID-AVERY CO., *Inc.*, PHILADELPHIA

The Welding Engineer

Founded by L. B. Mackenzie, 1916

Volume 13 | March, 1928 | Number 3

CONTENTS

Welding Speeds Auto Heater Production 27

Practical Studies of Electrodes 30
By Kenneth R. Hare

Welded Aluminum Tops for Buses 33
By L. R. McKean

Studies of the Welding Arc 35
By P. Alexander

A Student's View of Welding 41
By Paul Ross

Editorial 25
A. W. S. Program for Spring Meeting 29
Welding Rolls in Sugar Mill 37
Factors Involved in Economical Gas Cutting 39
Welding a 2200-Foot Vertical Pipe Line 43
Welding Piping Featured at Mid-West Power Show 43
Track Maintenance Cost Reduced by Welding 45
Red Shortness of Weld Metal (Discussion) 46
Manufacturer Favors Women as Welders 47
Preventing Buckling of Sheets When Welding 49
News of the Welding Trade 52

A Two-Edged Tool

ADVERTISING has two big jobs to perform—it helps the seller to sell, and it helps the buyer to buy. There is more to that statement than merely saying the same thing in two ways. It is true that some advertising, by its very attractiveness, does sell millions of dollars worth of soap, or chewing gum or underwear. But when a man is looking for a piece of equipment to do a certain job, he is out after facts. He cannot risk an investment of hundreds or thousands of dollars because of a pretty picture or a fancy piece of copy. The industrial advertiser knows this, and the wise reader of an industrial paper knows that he knows it. That accounts for the statement of one reader that he always finds time to go through the advertising pages, for just one reason—it pays.

Published on the 15th of Each Month by

THE WELDING ENGINEER PUBLISHING CO.,
608 S. Dearborn St., Chicago, Ill.
Telephone Wabash 7134

G. H. Mackenzie ..... President and Treasurer
M. J. Hungerford ..... Vice-President
H. S. Card ..... Secretary

H. S. Card ..... Editor
H. P. Ritsch ..... Associate Editor

Eastern Office—222 American Circle Bldg., New York
T. E. DePew, Eastern Manager
Telephone, Columbus 6941

Subscription payable in advance and postage free.
United States and possessions and Canada ..... $3 a year
Foreign Countries ..... $4 a year
Single copy, domestic ..... 25 cents
Single copy, foreign ..... 30 cents

Entered as second-class matter January 20, 1916, at the postoffice at Chicago, Illinois, under the act of March 3, 1879.

The Welding Engineer is a member of the Audit Bureau of Circulations and of the Associated Business Papers, Inc.

Last Advertising forms close at 8:00 a. m. on the 12th. To show proof for correction copy must be received at an earlier date and allowances should be made for delay to mails. All copy should be in by the 12th of the month at the latest.

The Welding Engineer does not publish in its news or advertising columns any matter that deals with or refers to either personal or legal controversies.

Authorized Representatives

CLEVELAND—R. K. Randall, 2094 E. 19th St.
DENVER—A. G. Odell, Public Opportunity School.
GREAT BRITAIN—Capt. D. Richardson, 26 Winterbrook Road, Herne Hill, London.
AUSTRALIA AND NEW ZEALAND—R. Hill, Matlock House, Davenport, Auckland, New Zealand.
SOUTH AFRICA—J. W. Arnison, 35a Victoria Ave., Benoni, Transvaal, South Africa.

Buyers' Index

Readers of The Welding Engineer will find this index to contain the most accurate information obtainable relating to welding apparatus and supplies. The advertising section includes the principal manufacturers of the United States.

ACETYLENE (Compressed in Cylinders)
Air Reduction Sales Co.
Commercial Acetylene Supply Co.
International Oxygen Co.
Prest-O-Lite Co.

ACETYLENE CYLINDERS
Keith Dunham Company
Pressed Steel Tank Co.

AIR LIQUEFACTION OXYGEN PRODUCING PLANTS
Keith Dunham Company
Heylandt Sales Co.

ALUMINO-THERMIC WELDING
Metal & Thermit Corporation

ALUMINUM SOLDER
Crown Aluminum Solder Co.
Weldene Corporation

ANNEALING FURNACES
General Electric Co.
Westinghouse Elec. & Mfg. Co

APRONS (Asbestos)
Ideal Face Shield Co.

ASBESTOS INSULATED WIRE AND CABLE
Central Steel & Wire Co.

BLOW PIPES
See "Torches."

BOOKS
The Welding Engineer Pub. Co.
Electric Arc Cutting & Welding Co

BRAZING OUTFITS
Air Reduction Sales Co.
Bastian-Blessing Co.
Craftsweld Equipment Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Alexander Milburn Co
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co
Victor Oxy-Acetylene Equipment Co.
Williams & Co.

BRONZE FILLER RODS
American Brass Co.
Central Steel & Wire Co.
Krembs & Co.
Mueller Brass Co.
Steel Sales Corp.

BUFFERS
R. G. Haskins Co.
N. A. Strand & Co.

BUTT WELDERS
See "Electric Resistance Welders"

CABLE (Arc Welding)
Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Lincoln Electric Co.
Quasi-Arc Weldtrode Co.
Una Welding and Bonding Co.
U. S. L. Battery Corp.
Westinghouse Elec. & Mfg. Co
Wilson Welder & Metals Co.

CARBIDE
Air Reduction Sales Co.
National Carbide Co.
Shawinigan Products Corp.
Union Carbide Sales Co.

CARBON (Blocks, Paste, Electrodes, etc.)
Air Reduction Sales Co.
Electric Arc Cutting & Welding Co.
National Carbon Co.
Oxweld Acetylene Co.

CARBON BURNING EQUIPMENT
Air Reduction Sales Co.
Bastian-Blessing Co.
Craftsweld Equipment Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co
Victor Oxy-Acetylene Equipment Co.

CAST IRON SOLDER
Crown Aluminum Solder Co
Weldene Corporation

CONSULTING ENGINEER
E. F. Hollinger
R. E. Kinkead
R. C. Pierce

CONTRACT WELDERS
S. O. S. Welding Corp.

CUTTING ELECTRODES (Electric Arc)
Allan Mfg. & Welding Co.
Electric Arc Cutting & Welding Co.
General Electric Co.
Lincoln Electric Co.
National Carbon Co.
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co
Wilson Welder & Metals Co

CYLINDERS (Acetylene)
Keith Dunham Company
Pressed Steel Tank Co.

CYLINDERS (Oxygen, Hydrogen)
Wm. Wharton, Jr. Co.

DRILLS, PORTABLE ELECTRIC
Stoody Company
N. A. Strand & Co.

ELECTRIC ARC WELDING OUTFITS
Allan Mfg. & Welding Co.
Burke Electric Co.
Chicago Steel & Wire Co.
Electric Arc Cutting & Welding Co.
Electric Welding Machine Co.
General Electric Co.
Goodman Electric Machinery Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Lincoln Electric Co.
E. A. Lundy Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Incorporated
Stoody Co.
Una Welding and Bonding Co.
Welding Service Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRIC RESISTANCE WELDERS
Federal Machine & Welder Co.
General Electric Co.
Gibb Welding Machines Co.
Goodman Electric Machinery Co.
R. D. Thomas Co.

ELECTRODES (Carbon Arc Welding)
See "Cutting Electrodes"

ELECTRODES (Metallic Arc Welding)
American Steel & Wire Co.
Atlas Foundry Co.
Central Steel & Wire Co.
Chicago Steel & Wire Co.
Electric Arc Cutting & Welding Co
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corporation
Koro Corporation
Lincoln Electric Co.
Page Steel & Wire Co.
Quasi-Arc Incorporated
Reid-Avery Co.
Roebling, John A., Sons Co.
Seneca Wire Mfg. Co.
Standard Steel & Wire Co.
Steel Sales Corp.
Stoody Company
Una Welding and Bonding Co.
Waters Arc Welding Corp.
Welding Service Co.
Wickwire Spencer Steel Corp.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRODE HOLDERS
Allan Mfg. & Welding Co.
Burke Electric Co.
Chicago Steel & Wire Co.
Electric Welding Machine Co.
Fibre-Metal Products Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Koro Corporation.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Una Welding and Bonding Co.
Welding Service Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.

ELECTRODE TIPS (Resistance Welding)
Elkon Works, Inc.

ELECTROLYTIC OXYGEN AND HYDROGEN GENERATING EQUIPMENT
International Oxygen Co.

FACE SHIELDS (Arc Welding)
Allan Mfg. Co. & Welding Co.
Burke Electric Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Incorporated
Stoody Company
Strauss & Buegeleisen
Una Welding and Bonding Co.
Westinghouse Elec. & Mfg. Co.
Williams & Co.
Wilson Welder & Metals Co.
Willson Goggles, Inc.

FILLER RODS
Air Reduction Sales Co.
American Brass Co.
American Steel & Wire Co.
Atlas Foundry Co.
Central Steel & Wire Co.
Craftsweld Equipment Co.
Oxweld Acetylene Co.
C. H. Hollup Corp.
Imperial Brass Mfg. Co.
Krembs & Co.
Mueller Brass Co.
Koro Corporation
Page Steel & Wire Co.
Reid-Avery Co.
Roebling, John A., Sons Co.
Seneca Wire Mfg. Co.
St. Paul Welding & Mfg. Co.
Standard Steel & Wire Co.
Steel Sales Corp.
Stoody Co.
Stulz-Sickles Co.
Torchweld Equipment Co.
Welding Service Co.
Wickwire Spencer Steel Corp.
Weldit Acetylene Co.
Williams & Co.

FIREPROOF PLASTIC MATERIAL
Air Reduction Sales Co.
Joseph Dixon Crucible Co.
National Carbon Co.

FLUE WELDERS (Electric)
General Electric Co.

FLUXES
Air Reduction Sales Co.
Anti-Borax Compound Co.
Metal & Thermit Corp.
Central Steel & Wire Co.
Krembs & Co.
Modern Engineering Co.
Oxweld Acetylene Co.
St. Paul Welding & Mfg. Co.
Torchweld Equipment Co.
Weldene Corporation
Weldit Acetylene Co.

GAS SAVING DEVICES
Harris-Calorific Co.
Weldit Acetylene Co.

Announcing—

Nichrome

TRADE MARK REG. U. S. PAT. OFF

Welding Rod

WELDS made with "Nichrome", the nickel-chromium alloy, possess exceptional strength.

For example, practical tests of welds on mild steel made with "Nichrome" rods, show an ultimate tensile strength as high as 55,000 pounds per square inch. In fact, "Nichrome" welds are practically as strong as the original cast "Nichrome."

You are assured of a good strong weld when you use "Nichrome" welding rod as "Nichrome" welds retain strength to a remarkable degree when subjected to high temperatures, the melting point being over 2500° F.

The physical characteristics of the metal itself include resistance to corrosion when in contact with strong acids and alkalies, low co-efficient of expansion, resistance to oxidation at temperatures up to 2000° F.

"Nichrome" welds are readily machineable and may be applied by either the oxy-acetylene or arc welding process. The ease of application and free flowing qualities of "Nichrome" welding rod, together with the fact that it can find wide application, make its use extremely desirable.

When making inquiries, state your particular problem. Sample rods will be furnished free.

DRIVER-HARRIS COMPANY

HARRISON, NEW JERSEY

Chicago - Detroit - Morristown, N. J. - England - France

GLOVES (Asbestos)
Ideal Face Shield Co.

GAUGES
Moto Meter Co.
National Gauge & Equipment Co.

GENERATORS (Acetylene)
Air Reduction Sales Co.
Bastian-Blessing Co.
Craftsweld Equipment Co.
M. Keith Dunham
Imperial Brass Mfg. Co.
Milburn, Alexander Co.
Modern Engineering Co.
Oxweld Acetylene Co.

GOGGLES
Chicago Eye Shield Co.
Ideal Face Shield Co.
Strauss & Buegeleisen
Wilson Goggles, Inc.

GRAPHITE (Rods, Blocks, Paste, Etc.)
Joseph Dixon Crucible Co.

GRINDERS (Portable Electric)
R. G. Haskins Co.
Stoody Company.
N. A. Strand & Co.

HELMETS (Arc Welding)
Allan Mfg. & Welding Co.
Burke Electric Co.
Chicago Eye Shield Co.
Electric Arc Cutting & Welding Co.
Fibre-Metal Products Co.
General Electric Co.
Gibb Welding Machines Co.
C. H. Hollup Corp.
Ideal Face Shield Co.
Lincoln Electric Co.
Northwestern Mfg. Co.
Owen Electric Mfg. Co.
Quasi-Arc Incorporated
Strauss & Buegeleisen
Westinghouse Elec. & Mfg. Co
Williams & Co.
Wilson Welder & Metals Co.
Wilson Goggles, Inc.

HOSE COUPLINGS
Carl A. Norgren Co.
See also under "Needle Valves"

HYDROGEN
Gas Products Association
International Oxygen Co.

HYDROGEN GENERATING PLANTS
International Oxygen Co.

LEAD WELDING UNITS
Air Reduction Sales Co.
Bastian-Blessing Co.
Craftsweld Equipment Co.
Harris Calorific Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Modern Engineering Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co
Victor Oxy-Acetylene Equipment Co.
Weldit Acetylene Co.

LIGHTERS (For Gas Torches)
Air Reduction Sales Co.
Bastian-Blessing Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Stevenson Distributing Corp.
Torchweld Equipment Co.

MANIFOLDS
Air Reduction Sales Co.
Bastian-Blessing Co.
Craftsweld Equipment Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co
Victor Oxy-Acetylene Equipment Co.

MECHANICALLY OPERATED CUTTING AND WELDING TORCHES
Air Reduction Sales Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

MOLDING MATERIAL
See "Fire Proof Plastic Material"

MONEL METAL RODS AND ELECTRODE
Central Steel & Wire Co.
Wilson Welder & Metals Co.

NEEDLE VALVES
Air Reduction Sales Co.
Bastian-Blessing Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
Torchweld Equipment Co
Victor Oxy-Acetylene Equipment Co.

NICHROME WELDING WIRE
Driver-Harris Co.

NITROGEN
Air Reduction Sales Co.
Gas Products Association
Linde Air Products Co.
International Oxygen Co.

OXYGEN
Air Reduction Sales Co.
Gas Products Association
International Oxygen Co
Linde Air Products Co.

OXYGEN PRODUCTION PLANTS
Keith Dunham Company
Heylandt Sales Co.

PREHEATING DEVICES AND OVENS
Imperial Brass Mfg. Co.
Metal & Thermit Corp.
St. Paul Welding & Mfg. Co.

RAIL BONDS
Una Welding and Bonding Co.

RAIL JOINT WELDERS
Una Welding and Bonding Co.

REAMERS (Portable Electric)
R. G. Haskins Co.
N. A. Strand & Co.

REGULATORS
Air Reduction Sales Co.
Bastian-Blessing Co.
Craftsweld Equipment Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
St. Paul Welding & Mfg. Co.
Stoody Company
Torchweld Equipment Co
Victor Oxy-Acetylene Equipment Co.
Weldit Acetylene Co.
Williams & Co.

SEAM WELDERS
See "Electric Resistance Welders"

SWEDISH IRON WELDING WIRE
Bissett Steel Co.

SPOT WELDERS
See "Electric Resistance Welders"

TANK CONNECTIONS
Air Reduction Sales Co.
Bastian-Blessing Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Oxweld Acetylene Co.
Torchweld Equipment Co.

THERMIT WELDING
Metal & Thermit Corp.

TORCHES (Welding and Cutting)
Air Reduction Sales Co
Craftsweld Equipment Co.
Bastian-Blessing Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
K-G Welding & Cutting Co.
Milburn, Alexander, Co.
Modern Engineering Co.
Oxweld Acetylene Co.
St. Paul Welding & Mfg. Co.
Stoody Company
Torchweld Equipment Co
Victor Oxy-Acetylene Equipment Co.
Weldit Acetylene Co.
Williams & Co.

TRUCKS (Cylinder)
Air Reduction Sales Co.
Imperial Brass Mfg. Co.
International Oxygen Co.
Torchweld Equipment Co.

VALVES
Air Reduction Sales Co.
International Oxygen Co.
Kerotest Mfg. Co.

WELDING COMPOUND (for Shape Welding)
Air Reduction Sales Co.
Joseph Dixon Crucible Co.
Modern Engineering Co.
National Carbon Co.

WELDING ROD HOLDERS
C. Sorensen

WELDING RODS AND WIRE
See "Electrodes" and "Filler Rods"

ALPHABETICAL INDEX TO ADVERTISERS

A

Air Reduction Sales Co. 3
Allan Mfg. and Welding Co. 64
American Brass Co., The 53
American Steel & Wire Co. 61
American Welding Society 62
Anti-Borax Compound Co. 66
Atlas Foundry Co. 56

B

Bastian-Blessing Company 26
Bissett Steel Co. 55
Burke Electric Co. 65

C

Central Steel & Wire Co. 9
Chicago Eye Shield Co. 60
Chicago Steel & Wire Co. 59
Commercial Acetylene Supply Co. 58
Craftsweld Equipment Co. ....
Crown Aluminum Solder Co. 64

D

Dixon Crucible Co., Joseph 65
Driver-Harris Co. 7

E

Elec. Arc Cutting & Welding Co. ..Back Cover
Elkon Works, Inc. .....Inside Back Cover
Electric Welding Machine Co. ....

F

Federal Machine & Welder Co. 57
Fibre Metal Products Co. 66
Fusion Welding Corporation 59

G

Gas Products Assn. ....
General Electric Co. 18, 19
Gibb Welding Machine Co 63
Goodman Electric Mach. Co. 54

H

R. G. Haskins Co. 64
Hollup, C. H. 21

I

Ideal Face Shield Co. 65
Imperial Brass Mfg. Co. 61
International Oxygen Co. 62

K

K-G Welding Co. 57
Kinkead, R. E. 66
Koro Corporation 60
Krembs & Co. ....

L

Lincoln Electric Co. 13
Linde Air Products Co. 14

M

Metal and Thermit Corp. ....
Alexander Milburn Co. ....
Modern Engineering ....
Moto Meter Co. 11
Mueller Brass Co. 12

N

National Carbide Co. 60
National Carbon Co. 10
National Gauge and Equipment Co. 11
Northwestern Mfg. Co. 63
Norgren, C. A., Co. 66

O

Owen Electric Mfg. Co. 17
Oxweld Acetylene Co. 16

P

Page Steel & Wire Co. 58
Pierce, R. C. ....
Pressed Steel Tank Co. 59
Prest-O-Lite Co., Inc., The 15

Q

Quasi Arc, Incorporated 23

R

Reid-Avery Co., Inc. 4
Roebling, John A., Sons Co. 24

S

Seneca Wire Mfg. Co. 55
Sorensen, C. 66
Shawinigan Products Corp. 64
Standard Steel & Wire Co. 54
Stevenson Distributing Corp. 62
Steel Sales Corp. ....
Strauss & Buegeleisen 66
Strand, N. A., & Co. 66
Stoody Co. 65
S. O. S. Welding Corp. ....
St. Paul Welding & Mfg. Co. 66

T

Torchweld Equipment Co. 59

V

Victor Oxy-Acetylene Equipment Co. 2

W

Weldene Corporation ....
Weldit Acetylene Co. 62
Westinghouse Electric & Mfg. Co. ....
Wickwire Spencer Steel Corp. 56
William Wharton, Jr., & Co., Inc. 56
Williams & Co., Inc. 63
Willson Goggles, Inc. 63
Wilson Welder & Metals Co. ....Front Cover

SWEDOX Will Do the Work—
we prove it before we ship it

Our complete stocks of selected rods, wires and electrodes enable us to supply material that has proven to be the best for your job, no matter what kind of a job it is. All of these materials have stood two severe tests, one in our laboratory and another in the customer's service.

SWEDOX

WELDING RODS, WIRES and ELECTRODES

Have been developed through research which started when welding started. It has all been aimed at finding the correct filler material for each individual welding requirement. Along with this proving quality you can be assured of exceptional service, because our three warehouses carry sufficient stocks to make immediate shipments on all grades.

Place an order for SWEDOX and see how satisfactory it is to get real tested quality backed by intelligent and experienced service.

WELDING CARBONS

We have recently become distributors of the products of

NATIONAL CARBON CO., INC.
Cleveland, Ohio

Our stock of National Welding Carbon Products is complete and includes Carbon Plates, Rods, Paste, Welding Electrodes and Graphite Electrodes.

ACCESSORIES FOR WELDERS

A complete stock of all welding accessories, including goggles, helmets, shields, gloves, electrode holders, lenses, etc., is carried in each of our three warehouses. Include whatever accessories you need in your next order.

Central Steel & Wire Company

CHICAGO, ILL.
4545 S. Western Blvd.
Lafayette 8500

DAYTON, OHIO
East Monument Ave.
Extended
East 150

DETROIT, MICH.
5001 Bellevue Ave.
Whittier 6780

Main Warehouses and General Offices, Central Steel & Wire Co., Chicago.

Announcing National High Capacity (H.C.) Welding Carbons

A COMPLETE line of National High Capacity (H.C.) Welding Carbons is now available to all users of the carbon arc welding process. These graphitized carbons can be furnished in all standard diameters and lengths. National H.C. Welding Carbons are highly recommended for use in cutting and for all carbon arc welding operations requiring electrodes of high current carrying capacity.

NATIONAL CARBON COMPANY, INC.
New York UCC San Francisco
Unit of Union Carbide and Carbon Corporation

Branch Sales Offices are located in
Chicago, Ill. Pittsburgh, Pa. New York, N.Y.
Birmingham, Ala.

NATIONAL WELDING CARBON PRODUCTS

BLOCKS
RODS
PASTE
FLOUR
ELECTRODES

The Discus Thrower, a beautiful piece of Ancient Greek sculpture, now in the Vatican Museum, Rome.

Enduring

The fact that Natweld Bourdon Springs for high pressure oxygen service are built of enduring bronze is a matter of vital significance to you.

Throughout the long life of Natweld Gauges these springs give unfailing, accurate service. They cannot rust; they do not corrode; for the nature of the metal prohibits such deterioration. They will not "set," for the Natweld process of manufacture gives them a higher degree of elasticity. In fact all the desirable characteristics for high pressure oxygen service have been worked into these springs.

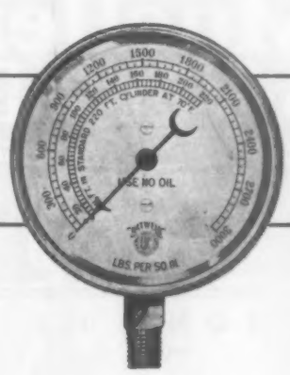
Natweld Gauges cost no more—for big production and volume sales together have made our present prices possible.

THE NATIONAL GAUGE AND EQUIPMENT CO.
La Crosse, Wisconsin
A Division of the MotoMeter Co.

The MotoMeter Company,
Long Island City, N. Y.
The MotoMeter Co. of Canada, Ltd.
Hamilton, Ontario

Chicago Office: 820 Tower Court
Represented in Illinois, Indiana, Wisconsin, Minnesota and Missouri
By Joseph Halla, 140 South Dearborn Street, Chicago, Illinois

NATWELD



GAUGES

an "Okay" that stands

You can safely place your "OK" on any job on which you use Mueller Welding Bronze Rod. Then you are sure it will give satisfaction.

Look for the name "MUELLER" stamped on each rod of Mueller Welding Bronze. It is a mark of quality that has stood for three generations.

Quality isn't left to chance in Mueller manufacture. Expert chemists analyze and test samples of each heat as it is poured. Our exactness is your assurance of the highest grade welding bronze at all times.

Make us prove that Mueller Welding Bronze Rod is the best — Write for a liberal sample free.

MUELLER BRASS CO.
Port Huron, Michigan
Detroit District

Mueller
Makes
Red Tip Brass Rod
Relleum Brass Forgings
Niag Nickel Silver Rod and Forgings
Tuf-Stuf Rod and Forgings
(*Corrosion Resisting Metal*)
Sandcraft Brass Castings
Brass Screw Machine Parts
Mueller Blue Tip Bronze Rod
Brass and Copper Seamless Tubing
Mueller Blue Tip Bronze Welding Rod

Mueller
WELDING
BRONZE ROD

Mueller Brass

THREE GENERATIONS OF BRASS MAKING

Will Pop use the (non-splashing) rod?

"Here, Lad... "Yes, Pop...

you've been talking to some of the welding boys in the shop about how they liked the samples of that Lincoln 'Stable-Arc' BLUE welding rod.

Now lay off that, because they ought to use the rod I buy them . . . and besides I hear that this BLUE rod is no better than any other."

you hear that, and the men hear that you **believe** it.

The men DON'T believe it.

Who knows best which is the best welding rod . . . the man who is trying to save a cent a carload or the man whose job it is to do good work and fast work?

If a good welder is provided with a good machine like the Lincoln 'Stable-Arc' . . . why not give him the 'Stable-Arc' BLUE rod (non-splashing)!

Know your rod and don't believe all you hear.

The only time it's safe to believe all you hear is when the locomotive whistles at the crossing."

A new textbook on Arc Welding (Price $1.50) will be sent on approval for five days to any executive requesting it.

Book size, 6"x9"—total pages, 160—number of illustrations, 200—Charts, 62—Divisions, 8.

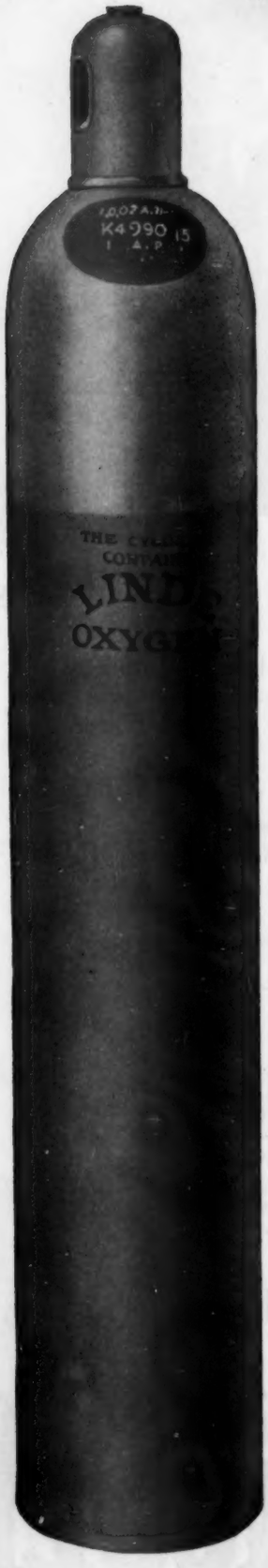
The Lincoln Electric Co., Dept. No. 27-2, Cleveland, Ohio

W-32

"Stable-Arc"

LINCOLN WELDER

THAT LINDE LABEL means



1 A quality product—the standard for more than 20 years.

2 Fast delivery from the nearest of 152 distributing points.

3 The economical use of oxygen through Linde Process Service.

Incidentally, have you seen the Linde magazine—"Oxy-acetylene Tips?" We'll be glad to send you a copy. It's part of Linde Process Service.

LINDE OXYGEN

THE LINDE AIR PRODUCTS CO.

Unit of Union Carbide and Carbon Corporation

UCC

General Offices:

Carbide and Carbon Building
30 East 42d St., New York

47 Plants 105 Warehouses

Eventually you'll standardize on Prest-O-Lite DISSOLVED ACETYLENE

Because one of the 139 Prest-O-Lite distributing points is near you.

Because over a period of 23 years this service has proved its reliability and economy.

THE PREST-O-LITE COMPANY, INC.
Unit of Union Carbide and Carbon Corporation

UCC

General Offices: Carbide and Carbon Building, 30 East 42d St., New York
37 Plants—102 Warehouses

Keeping out poor welds

The best welds can be made only with the best welding rod. It is a plain case of metallurgy.

That's why Oxweld welding rod is manufactured to meet rigid specifications. Not only is chemical analysis specified but actual welding tests are made with every lot of rod before it is stamped with the Oxweld trademark.

OXWELD ACETYLENE COMPANY

Unit of Union Carbide and Carbon Corporation

NEW YORK CITY, 30 E. 42d St. UCC STOCKS IN 41 CITIES

CHICAGO, 3642 Jasper Place SAN FRANCISCO, 8th & Brannon Sts.

IN CANADA, Dominion Oxygen Company, Ltd., Toronto

Oxweld

WELDING AND CUTTING APPARATUS

What makes the OWEN the favorite

THE OWEN INDUCTION ARC WELDER
Size, 13x27x21 inches. Weight, 190 pounds.
Approved and Accepted by National Board of Underwriters

in hundreds of welding shops

The extreme simplicity of the Owen, with no moving parts to wear out, nothing to get out of order, nothing to adjust, no rheostat or other auxiliary equipment, —all this accounts for the great popularity of the Owen Induction Arc Welder.

Built for a lifetime of satisfactory service

The OWEN Meets Every Welding Requirement

The most economical arc welder built. Uses only one-fourth the power required by most D. C. welders, and only one-half the power required by all other A. C. welders.

Owen Induction welds are as **strong** and **ductile** as the parent metal, easily filed, machined, drilled or threaded.

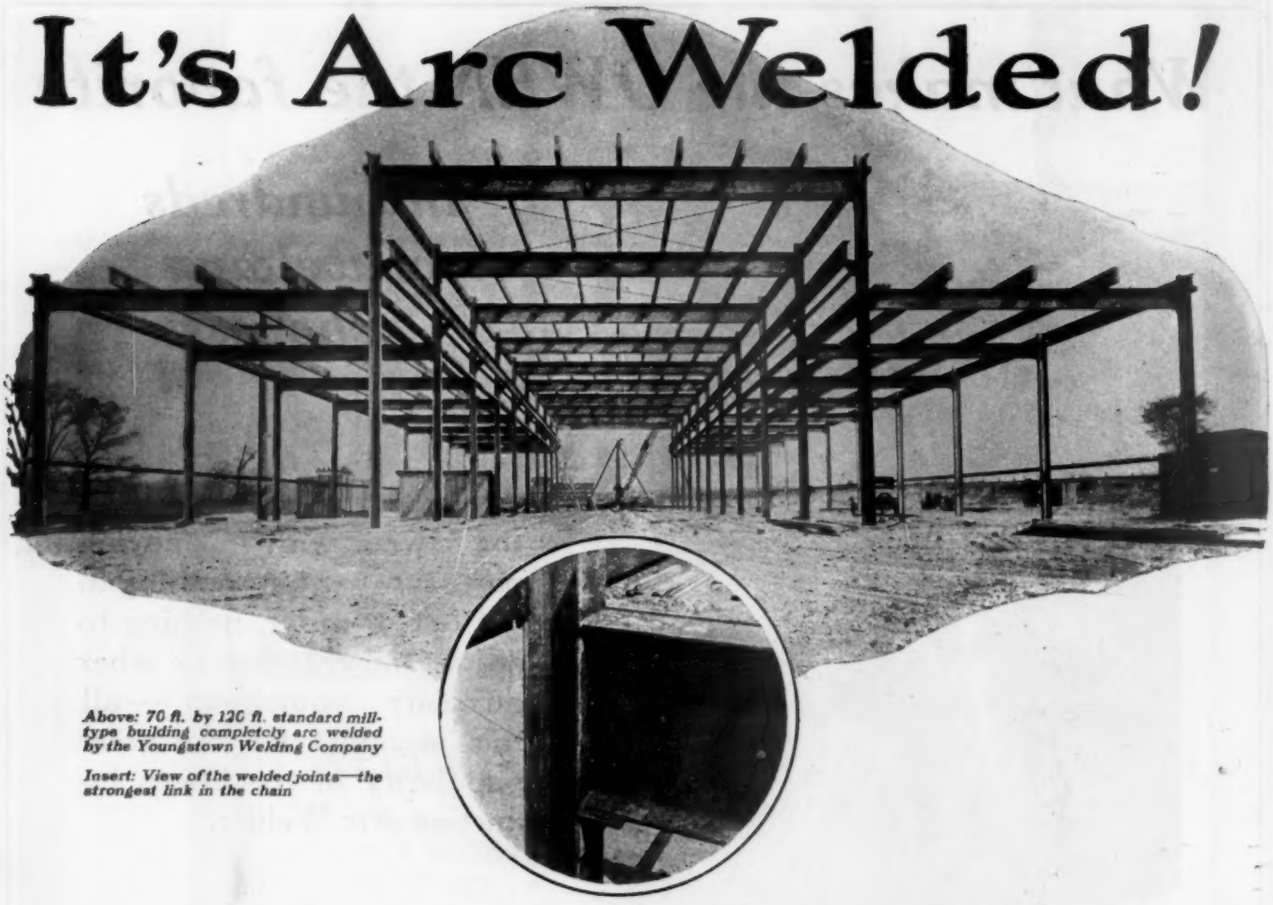
Scores of applications heretofore considered out of the range of the average shop are now accomplished with ease and certainty.

OWEN ELECTRIC WELDER CO.

General Distributors

717-18 W. O. W. Building **Omaha, Nebraska**

It's Arc Welded!



Above: 70 ft. by 120 ft. standard mill-type building completely arc welded by the Youngstown Welding Company

Insert: View of the welded joints—the strongest link in the chain

7 men did it—in 15 days. They used two arc welders, a burning outfit, a welded derrick, and a tractor. Not one rivet or bolt was used in fabrication or erection.

Total cost of fabrication and erection.....$530
Estimate for similar riveted job (*erection only*)...$540

Fabrication by arc welding means these practical advantages:

- Engineering work greatly simplified
- Elaborate auxiliary drawings eliminated
- Structural shop eliminated—all work done in the field
- Handling charges reduced—materials shipped directly from mill to job
- Large saving in materials
- Flexibility—changes in design during construction easily made with no waste of materials
- Field equipment simple and inexpensive—total for above job, $3000

This is just a beginning. Experience will bring greater simplification, greater speed, greater economies. Your nearest G-E office will be glad to give you the complete details of this job and much valuable information as to the G-E welder best suited to the fabrication of structural steel. Write or phone.

General Electric furnishes to the Welding Industry:

- WD Arc Welders—designed for one operator
- Constant Potential Sets—for several operators
- Arc Welding Resistors—for mining and traction companies
- Automatic Sets—for repetition work

Complete information and bulletins available at your nearest G-E office.

530-27

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, SCHENECTADY, N. Y., SALES OFFICES IN PRINCIPAL CITIES

The Perfect Weld

A perfect weld needs more than a skilled operator. His welding equipment must match his workmanship. From power line to bead, General Electric offers a complete, dependable service—welding machines, welding accessories, and *welding electrodes*.

There is a right electrode for each job—that's why General Electric manufactures three types.

Type "F" is a bare wire treated by a special General Electric process to obtain a stable, concentrated arc. It is used for general welding of steel.

Type "B" is best for automatic welding. The concentrated arc confined by encasing the flux around the core in the sheath gives remarkable penetration for higher-speed welding.

Type "A" is recommended for cast iron.

Each type is the result of a careful study of every welding requirement —each is of proved excellence. By the use of G-E welding electrodes, you can be sure of sound, tough welds.

Special distributors for G-E Welding Electrodes located throughout the country are equipped to give you prompt service. Get in touch with the G-E Welding Electrode Distributor near you or write to the Merchandise Department, General Electric Company, Bridgeport, Connecticut.

In absolute reliability of operation and over-all efficiency, G-E Arc Welders are unequalled. They are available in all sizes, all types—for either hand or automatic operation — for one or more operators.

550-201

GENERAL ELECTRIC

MERCHANDISE DEPARTMENT, BRIDGEPORT, CONNECTICUT

Pipe Cutting Simplified

Many of the patterns required for cutting pipe to make up welded fittings would take hours of time to develop in the drawing room.

Even the simplest patterns are difficult to make when one is not familiar with the principles of mechanical drawing.

Consequently, welded fittings may be costly to make, due to imperfect cutting.

As a solution of the cutting problem, we have for sale a complete set of full size blue prints of curves, which enable you to cut your connections *correctly and accurately* the *first* time.

THIS SET INCLUDES THE FOLLOWING CONNECTIONS:

PIPE PATTERNS
2" 3 Piece Ell
2" 45° Ell
2" Rt. Angle Ell
2" Lateral
2" Round End
2" Tee
3" 3 Piece Ell
3" 45° Ell
3" Rt. Angle Ell
3" Lateral
3" Round End
3" Tee
3" Y
3" Split Bull Plug
4" 3 Piece Ell
4" 45° Ell
4" Rt. Angle Ell
4" Lateral
4" Round End
4" Tee
4" Y
4" Split Bull Plug
6" 3 Piece Ell
6" 45° Ell
6" Rt. Angle Ell
6" Lateral
6" Round End
6" Tee
6" Y
6" Split Bull Plug
8" 3 Piece Ell
8" 45° Ell
8" Rt. Angle Ell
8" Lateral
8" Round End
8" Tee
8" Y
8" Split Bull Plug
10" 3 Piece Ell
10" 45° Ell
10" Rt. Angle Ell
10" Lateral
10" Round End
10" Tee
10" Y
10" Split Bull Plug
12" 3 Piece Ell
12" 45° Ell
12" Rt. Angle Ell
12" Lateral
12" Round End
12" Tee
12" Y
12" Split Bull Plug
4x3 Tee
6x3 Tee
6x4 Tee
8x6 Lateral
8x3 Tee
8x4 Tee
12x3 Swedge Nipples
12x4 Swedge Nipples
12x6 Swedge Nipples
12x8 Swedge Nipples
12x10 Swedge Nipples
10x3 Swedge Nipples
10x4 Swedge Nipples
10x6 Swedge Nipples
10x8 Swedge Nipples
8x6 Swedge Nipples
8x4 Swedge Nipples
8x3 Swedge Nipples
6x4 Swedge Nipples
6x3 Swedge Nipples
4x3 Swedge Nipples
3x2 Swedge Nipples

CASING PATTERNS
5 3/16" 3 Piece Ell
5 3/16" 45° Ell
5 3/16" Rt. Angle Ell
5 3/16" Lateral
5 3/16" Round End
5 3/16" Tee
6 5/8" 3 Piece Ell
6 5/8" 45° Ell
6 5/8" Lateral
6 5/8" Round End
6 5/8" Tee
8 1/4" 3 Piece Ell
8 1/4" 45° Ell
8 1/4" Lateral
8 1/4" Round End
8 1/4" Tee

ODD SIZE TEES
5 3/16Cx3" I. D. Tee
5 3/16Cx4" I. D. Tee
6 5/8Cx4" I. D. Tee
6 5/8Cx3" I. D. Tee

With these curves you can make patterns for any of the above on any desired material, without the use of mathematics or drawing instruments. They will save many times their cost.

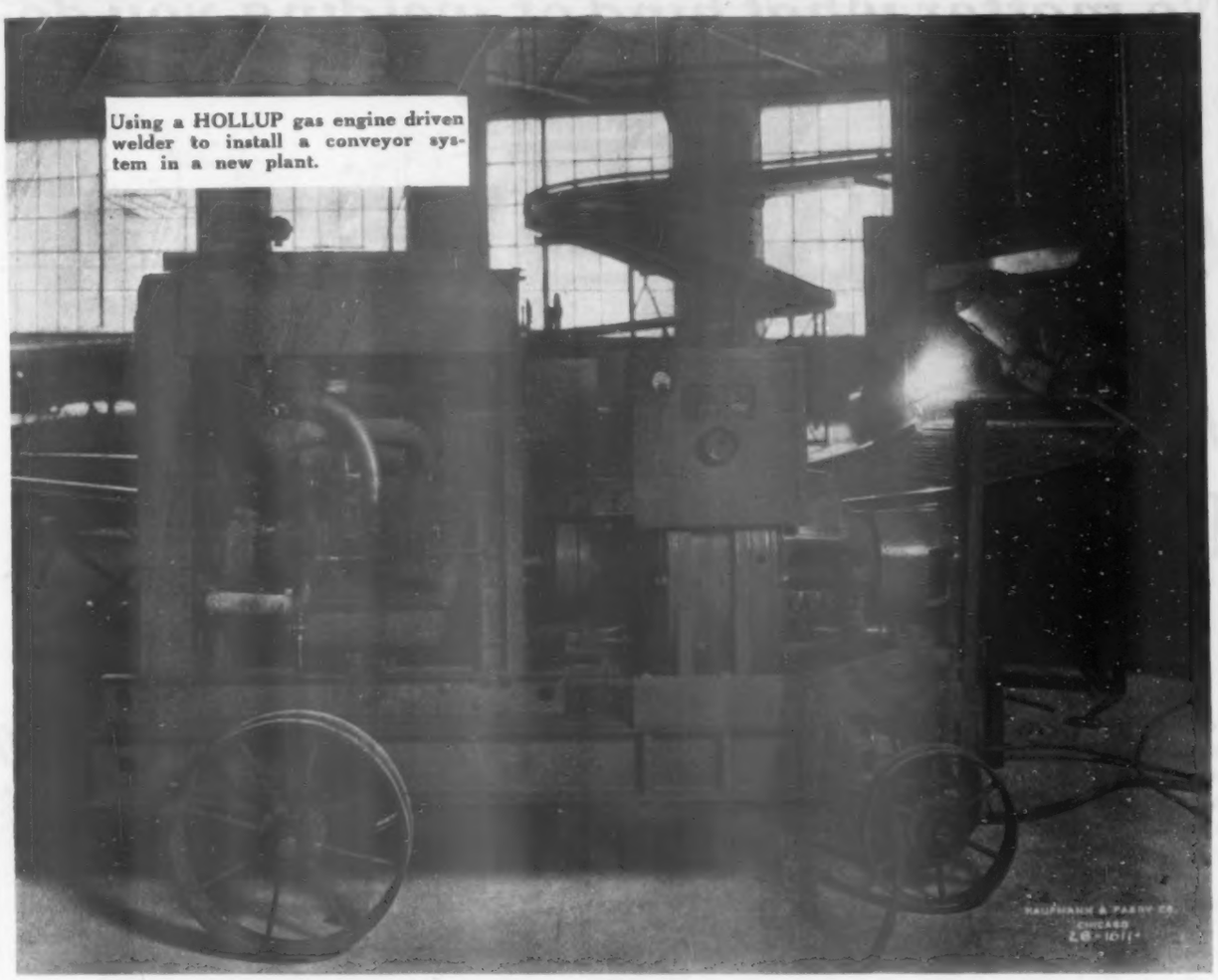
Price $20.00

An Opportunity for Job Welders

These patterns will enable you to make up welded pipe fittings, which will be better and cheaper than cast fittings. This new and profitable line of business is a fine possibility in every locality.

The Welding Engineer

608 S. Dearborn Street
CHICAGO, ILLINOIS



Using a HOLLUP gas engine driven welder to install a conveyor system in a new plant.

Modern Plant Construction Is at Its Best When It Is Welded Construction; and Welding Is at Its Best When It Is Done with

HOLLUP

Welding Products

HOLLUP ARC WELDING MACHINES are designed by arc welding experts, who have solved the problem of getting a machine to deposit the maximum amount of metal with minimum labor. These efficient welders are compact, safe, strong, and convenient. They stand as another achievement of the HOLLUP organization in reducing the labor item, the largest item of welding cost. (200 and 300 ampere capacities furnished with gas engine drive as shown above or with electric motor drive.)

HOLLUP WELDING ELECTRODES are made under uniform control methods which extend from the selection of the material to the final processing which guarantees their exceptional welding qualities. They are a necessity on particular work, such as railway maintenance, and an economy on production welding of all kinds—not only better, but easier to use.

Send for a copy of BULLETIN NO. 130 You should read it

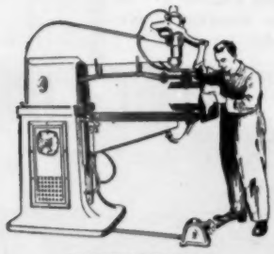
C. H. HOLLUP CORPORATION

3333 W. 48th PLACE CHICAGO, ILL.

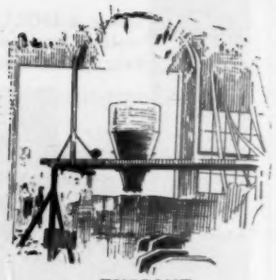
No matter what kind of welding you do--

OXY-ACETYLENE

ELECTRIC ARC



RESISTANCE

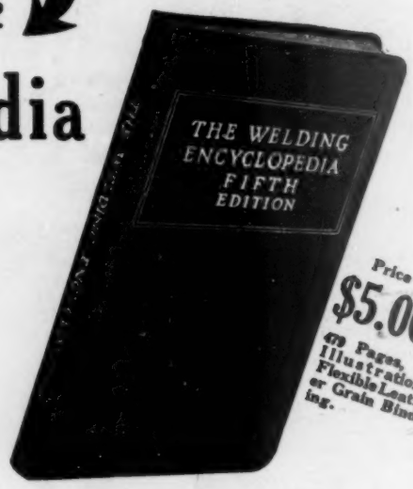


THERMIT

If you Weld, you need this book

The Welding Encyclopedia

Fifth Edition



Price **$5.00**

470 Pages, 625 Illustrations. Flexible Leather Grain Binding.

It describes in detail the theory and practice of every welding process. It tells how to weld every weldable metal by each of the welding processes. It gives detailed instructions for handling the important welding jobs, such as boiler welding, sheet metal welding, tank welding, pipe welding, etc. It tells how to prepare parts for welding. It tells how to install and care for welding equipment. It explains the meaning of all words and terms found in welding literature. It tells where to buy all standard makes of welding apparatus and supplies.

Contents

1. Illustrated encyclopedia covering all words, terms, and trade names used in welding.
2. Oxy-Acetylene Welding.—Aluminum, Steel, Cast Iron, Brass, Bronze. (Full instructions for welding each of these metals.)
3. Electric Arc Welding.—Complete instructions for welding all metals, studding, cutting, etc.
4. Electric Resistance Welding.—Includes Butt Welding, Line Welding, Percussion Welding and Spot Welding.
5. Thermit Welding.—The most complete treatise on this process ever published.
6. Cutting Metals.—Treatises on both gas and arc cutting. Includes cast iron cutting and automatic cutting.
7. Boiler Welding.—Gas and Electric Processes. Suggestions, procedure, and standards of practice.
8. Complete chapters on Pipe Welding, Rail Joint Welding and Tank Welding, explaining procedure in detail.
9. Rules and Regulations.—What can be welded and what cannot be welded. Rules also govern the installation and operation of equipment.
10. Complete instruction courses in Electric Arc Welding and Oxy-Acetylene Welding. Lessons, Exercises, Reference Readings, Examinations.
11. Charts and Tables.—A fund of welding information at a glance. Includes color chart showing colors at various temperatures, and color chart showing proper adjustment of oxy-acetylene welding flame.
12. Condensed Catalogs.—Up-to-date information about the leading makes of welding apparatus and supplies. The Buyers' Index is a convenient and reliable guide to the man who purchases or recommends welding apparatus.

The Welding Encyclopedia is Used by:

Welding Shops	Lumber Companies
Garages	Ice Plants
Boiler Shops	Power Plants
Round Houses	Auto Body Works
Car Shops	Ornamental Iron Works
Scrap Yards	Sheet Metal Shops
Refineries	Shipyards
Auto Factories	Gas Plants
Tank Builders	Foundries
Street Railways	Machine Shops
Airplane Factories	Pipe Line Companies
Steel Mills	Industrial Plants

THE WELDING ENGINEER PUBLISHING CO.,
608 S. DEARBORN ST., CHICAGO, ILL.

Please send me a copy of The Welding Encyclopedia, Fifth Edition, for which find enclosed five dollars. I understand that I may keep it for five days for examination and if it is not satisfactory I may return it and you will refund the purchase price.

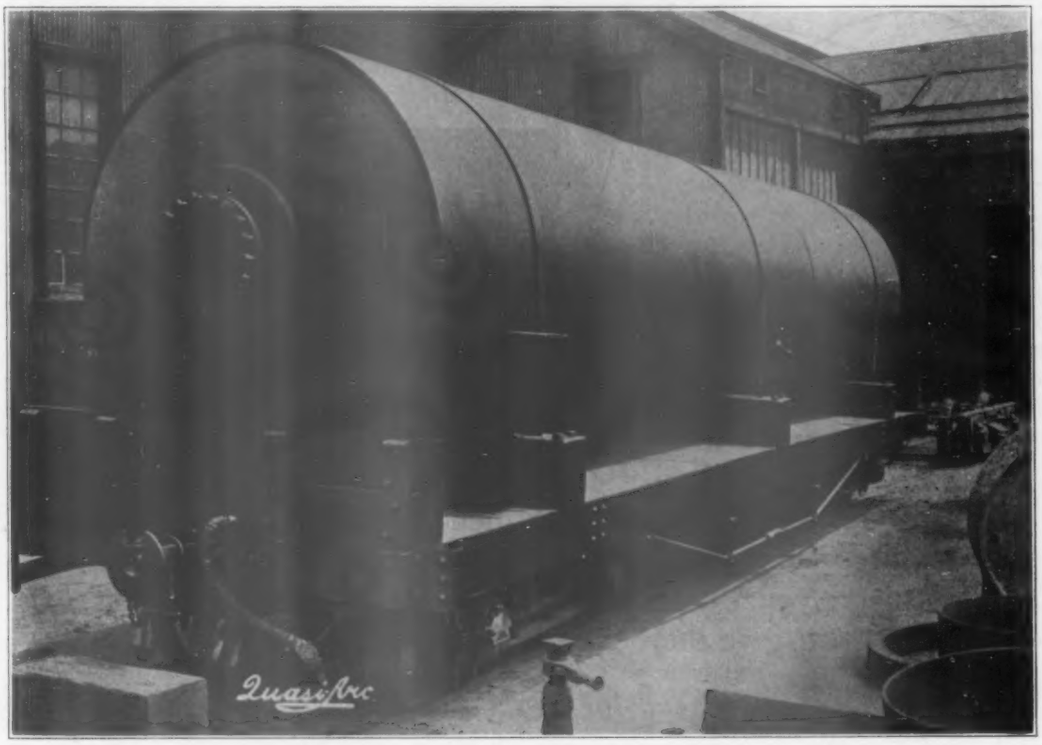
Name _____

Street _____

Postoffice _____ _____

Quasi-Arc

ALL WELDED GAS STORAGE TANK



Length 30 feet; Diameter 6 feet; Plate-thickness ½ inch; Gas Pressure 160 lbs. per sq. in.

A number of Gas Storage Tanks, similar to the one shown above, were designed and built by a Railroad Company using QUASI-ARC Electrodes after very exhaustive tests were carried out giving the makers perfect confidence in the use of our products.

The reasons why we recommend that YOU should use QUASI-ARC Electrodes for this class of work are:—

1. **100% Strength Joints.**
2. **High Endurance Limit of Weld Metal under Alternating Stresses.**
3. **Outstanding Resistance against Corrosive Action.**

QUASI-ARC INCORPORATED

Sole Manufacturers of Quasi-Arc Electrodes and Welding Equipments and Consultants in Reference to their Application.

11 WEST 42nd STREET, NEW YORK, N. Y.

Roebling

Welding Wire can always be relied upon for uniformity and perfect flowing quality. Roebling Electrodes are carried in all the standard sizes (14 inch lengths), also Gas Welding Wire (36 inch lengths.) Other sizes required will be manufactured to order. Tell us the kind of metal you desire to weld—we will supply the wire which will give the best results.

Send for booklet A-529

John A. Roebling's Sons Company, Trenton, N. J.

EDITORIAL

An Artist's Picture of the Future

THE other day we saw one of those Wellsian pictures of the sort of world this old globe is going to become after humanity has had a few more centuries in which to remodel it. In the foreground was a lot of machinery, with appurtenances such as tanks, boilers, piping, and supporting structures. To this whole system there was a graceful continuity that was unmarred by a single bolt, flange, gusset plate or rivet. It certainly looked like a completely welded job.

The artist may have omitted these details through ignorance, but the point of his picture was that the human race is elevating itself to a higher order that will be more sensitive to inharmonious sights and sounds, and with a higher sense of the esthetic as well as the utilitarian. Follows logically the question whether this improved humanity will tolerate the maddening noise of the rivet hammer, or the sight of large and small bulks of unnecessary material in flanges, fittings, castings, structural connections, and the like. Man has always had a way of discarding that for which he no longer has any use, in spite of the backward pull of tradition. And he is not slow to adopt that which is better for a purpose. In the course of his eternal march toward better things to come, it just happens that he has found that a quicker, more efficient, more economical, and more lasting method of joining two pieces of metal is to fuse them together. Welding has not solved all fabricating problems, nor have all welding problems been solved. But it is significant that more and more engineers who are going forward with the rest of the column toward the objective are taking the torch and the electrode with them.

Creative Selling

IN THE early days of the development of the automobile it was thought that the presence of iron and steel objects on the highways was a natural hazard to tires which must simply be endured. They were there, and they caused punctures, and the unfortunate motorist simply had to put up with it. It was sometime before an enterprising manufacturer of electrical equipment conceived the idea of demonstrating that it was practical and economical to sweep the highways with powerful magnets to remove this tire hazard from the ground. One such magnet suspended from the rear of a five ton truck is reported to have picked up one hundred fifty pounds of nails, wire and scrap iron on five miles of one road. On another trial fifteen hundred and seventy pounds of such material was picked up in a one hundred mile stretch, the average number of pieces of sharp pointed metal per mile being forty-five. It took enterprise and merchandising ability for the manufacturer of this equipment to demonstrate its usefulness to the public. Many manufacturers in the welding industry consider that welding equipment of all kinds has similar possibilities of making savings and accomplishing production miracles far beyond the opinion generally held by the public. These possibilities will not, however, become accomplished facts until enterprise and merchandising ability have been brought to bear to make executives throughout the metal working trades realize as much of the usefulness of welding as county commissioners are being told about the value of the road sweeping magnet.

Where the "Human Element" Does Come In

THE engineer in charge of a certain production job, although he had been skeptical of welding because of the "human element" involved, decided to try welding his product. Without changing the design, without considering the physical properties or analysis of the materials used, and without studying the welding processes themselves, the engineer called in a welder and told him to fabricate the parts. The result was what might be expected: the job failed to hold up. And the welding was cursed because of the human element of the operator. The fact of the matter is, there was considerable human element involved, but chiefly on the part of the engineer himself. His failure to take into account the differences between welding and other means of joining metals, and the properties of the materials and of other materials which might have been used to better advantage, and his failure to consider which welding process was best suited to the job, and to adapt his design to accommodate it to welding, all may have been human enough, but poor engineering never the less, and placed before a skilled welder handicaps which made a good job well nigh impossible. The improvement in the product which welding can make possible, with often an actual saving in production cost, certainly justifies the application of the same scientific study of design and procedure that was originally applied in the development of the product. The experiences of hundreds of large manufacturers proves that, this having been done, welders can be secured who, though human, are dependable, conscientious craftsmen.

A Real Get-Together

ONE of the items of very active interest in the gas welding industry at this time is the possibility of a combined meeting of the Compressed Gas Manufacturers Association, the Gas Products Association and the International Acetylene Association at some time during the summer. It has been the custom of the first two groups to have summer meetings annually and both of them have been well attended and are looked forward to as weeks of both pleasure and profit by the members. However, there are quite a number who belong either to two out of the three associations mentioned or to all three of them, and when meetings are held at different places and different dates it means quite a sacrifice of time to take them all in. The associations have a great deal in common, although their most important activities are along somewhat different lines. If they can all get together for a week during the coming year there will be an opportunity for joint discussions of common problems which have never before been offered to the members. In the past there has been a great deal of harmonious work done by these three organizations whenever their interests were brought together on special questions. The opinions in favor of getting the three associations together for a sort of joint meeting have been freely expressed. Consequently there is little doubt about the possibility of large attendance in case arrangements can be made which are satisfactory to everybody. In view of the splendid possibilities for a better understanding and more advanced cooperation between these three important groups, the details of time and place seem to be a secondary consideration. The project of a joint meeting has been the subject of conversation for several years. Undoubtedly if it graduates from the stage of conversation to the stage of action the result would be so satisfactory that similar meetings in future years will be arranged without difficulty as a matter of course. It is not an untried experiment by any means. There are numerous instances throughout the year when associations having common interests, have arranged their meetings for the same time and place, both as a matter of convenience to the members and a matter of making possible a more smoothly working program of action on subjects which require the attention of all the organizations concerned.

The New REGO XL Regulator

Forged Brass Throughout
Large Expansion Chamber
Loose, Clamped Diaphragm
No Solder
Non-wearing Adjusting Screw
Many Patented Safety Features

The New REGO XL Regulator

The Last Word in
Regulator Efficiency, Safety
and Economy

The proper operation of your torch is dependent on a good regulator. Write for Catalogue 51-D

The Bastian-Blessing Company

240 East Ontario St. Chicago, Ill.

REGO is sold by over 200 distributors

Welding Speeds Auto Heater Production

Seam, Spot and Oxy-Acetylene Welding Coordinated to Produce the Most Efficient Construction and the Most Economical Production

YEARS of experimentation and research have resulted in the present design of the Bovey Hot Air Core Automobile Heater and in the production procedure which makes possible such safe and efficient construction on an economical basis. The problem the designers set out to solve was the absolute elimination of all possibility of leakage of gases from the motor exhaust into the air which heats and ventilates the automobile. This has been accomplished by the use of a hot air core of heavy gauge seamless steel tubing which extends as one piece entirely through the center of the heater exhaust casing shell or body, without any

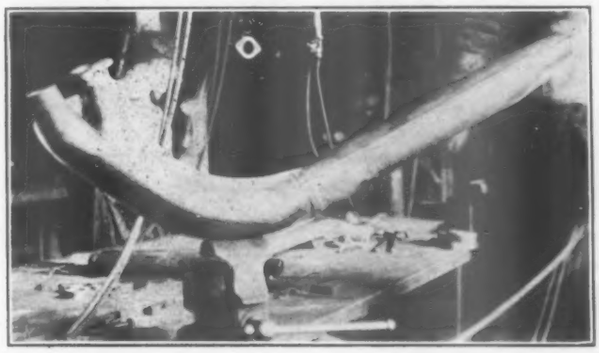


Fig. 1.—Exhaust Gas Casing, Showing Seam Welds and Brazed Joints.

joints or seams of any kind that might fail to keep separate the currents of exhaust gases and hot air.

When, after much experiment, it was decided to flange the main parts of the heater body exhaust gas casing and join the semi-circular halves of the casing shell by seam welding along the flanges, several difficulties in design were encountered. It was

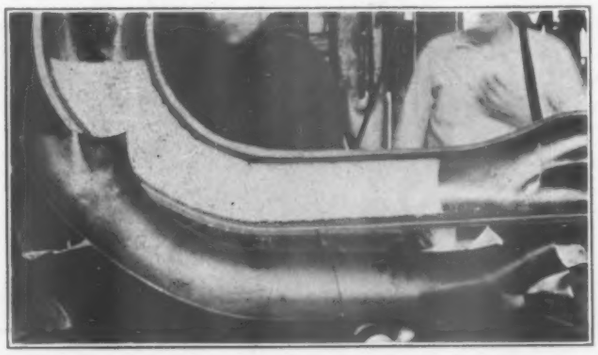


Fig. 2.—Heater Body Asbestos Lined, With Protective Inner Lining Spot Welded to Casing.

discovered, for example, that the radius of curvature of some of the exhaust casing parts was too short to allow seam welding, and as this process was most economical for this part of the assembly the design was changed accordingly.

It was then found that with the 18-gauge material used for the exhaust casing shell, the seams as they came from the welder were not always tight (not important from the safety standpoint as any leak in this part of the heater structure would only cause the exhaust gas to be released to atmosphere). Furthermore, the weld is stopped an inch short of the end of the seam, to prevent burning, and consequently this process is followed by gas welding of the joint, usually without the use of any filler material. This combination of the two processes has produced an absolutely gas-tight joint, with a minimum of time and practically no material.

In fact, the use of oxy-acetylene and of spot and seam welding has been so proportioned and synchronized as to produce the best and most uniform results with the most economical procedure.

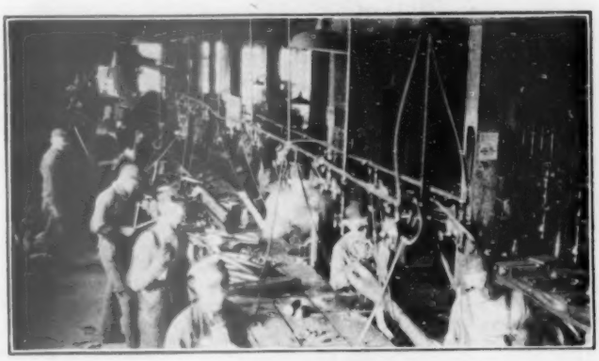


Fig. 3.—Assembly Line, Showing Overhead Manifold Serving Twelve Welders.

That the production program has been worked out on an efficient basis is evidenced by the fact that an entire heater body, including some dozen parts, gas, spot, and seam welded, is completely assembled in about 35 minutes of actual working time.

The exhaust casing body is made of 18-gauge pickled and annealed sheet steel, with an asbestos lining ⅛ in. thick, held in place by a protective lining of 24-gauge sheet steel, spot welded

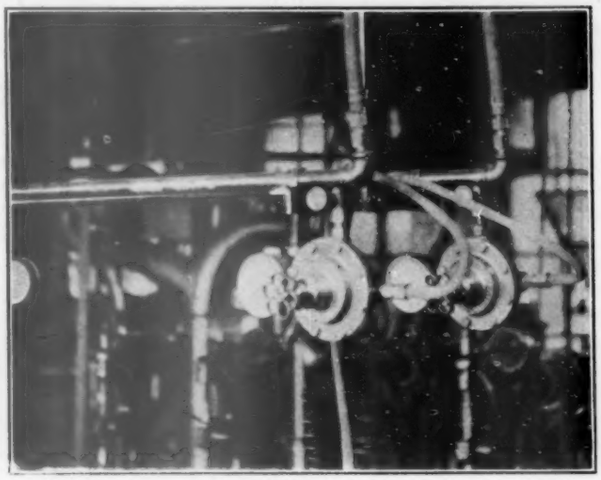


Fig. 4.—Sets of Gauges and Regulators Spaced Conveniently on Manifold.

at the edges to the heater body. The hot air core of 2-in., 16-gauge seamless steel tubing which passes through the full length of the heater is brazed to the exhaust casing body at each end with phosphor bronze. It was found that ordinary bronze weld metal did not have sufficient strength at the temperatures often reached. Phosphor bronze, on account of its higher melting point, has proved excellent for this purpose. This rod was adopted after considerable experiment with bronzes of various analyses. Each analysis was tested by brazing two strips of steel ⅜"x1" and 2 in. long, and supporting this 4-in. brazed rod at the ends

on fire brick and placing in a furnace, until the strips sagged in the middle and finally fell apart. The rod selected as a result of this test is the one sold as Torchweld Special brazing rod.

When each half of the rear end and front radius has been completed, the parts are assembled in an efficient system of jigs and tack welded with the torch along the flanged edges. This operation takes three men 5½ minutes. The assembly next goes

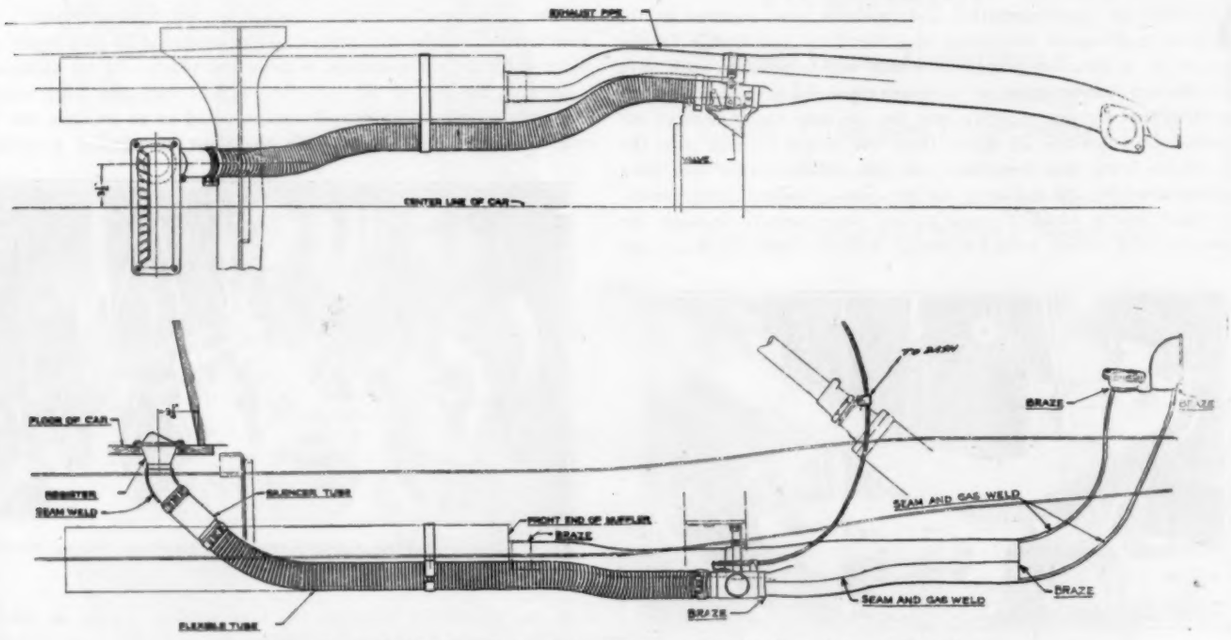


Fig. 5.—Top and Side Views of Complete Assembly of Hot Air Core Automobile Heater.

to the seam welder, which completes all of the longitudinal seams in 1¾ minutes.

After grinding to remove rough spots the body is placed in a bench vise, and touched up with the torch in the places inaccessible to the seam welder, as described above. The rear section and the front section of the exhaust casing body are brazed together.

Fig. 6.—Intake Pipe, Seam Welded, and Fittings, Spot Welded.

The exhaust neck or collar carrying the standard flange for connecting the heater unit to the engine exhaust manifold is welded. All of these gas welding operations require a total of about 17 minutes, and consume one ounce of 3/32-inch bronze rod and 1¾ cu. ft. of gas, using a No. 3 tip and 4 lb. pressure on both oxygen and acetylene, a No. 1 equal-pressure torch being used.

All oxygen and acetylene is manifolded direct to the operators through a ¾-inch brass pipe line, each line being supplied from two batteries of four cylinders each, so arranged through a double Y-valve that one battery of four tanks will carry the load while the others are being replaced, thus assuring a steady supply of gas. The pressure at the cylinders is 15 lb., and is stepped down to 4 lbs. through a set of regulators at each of the 18 outlets. The manifold is supported from the ceiling, and hose arresters are placed between each six sets. This time-and space-saving gas supply system was designed and installed by an engineer of the Torchweld Equipment Company, whose torches and regulators are used in this installation. Most of the torches are of the automatic type.

Five portable outfits are used in addition, to speed up production wherever temporary slack develops in the assembly line. A separate manifold leads to the floor above where women operators do the more delicate welding on such parts as the valves, elbows, and air intakes, using a No. 2 tip on this work.

Fig. 7.—Efficient System of Jigs Speeds Production.

The intake pipe shown in Figure 6 is seam welded, and the fittings spot welded, both being made airtight by going over the seams with the torch and $\frac{1}{16}$-inch steel rod.

The problem of keeping the air in the hot air core tube in circulation in such a way as to bring all of it in contact with the heating surface was solved simply by running a twisted steel ribbon "impeller" through the core, and then brazing to the inside of the core at each end.

In operation, this heater is as efficient as it is simple. The air enters through an intake or funnel in proximity to the motor fan, goes through the hot air core tube which is surrounded by the hot exhaust gases before they go to the muffler. The air then passes through flexible steel tubing and a fabric silencer to the

floor register. The positive acting valve is operated from the dash.

One of these heaters was installed on a Buick which traveled continuously for 19,000 miles at high speed on the proving grounds. At the end of the run the heater was removed and inspected and found as good as new.

The features of safety and durability, as well as the economical and expeditious production procedure, have been made possible largely through the proper application of the seam, spot and oxy-acetylene welding processes, each with its own definite function to perform.

A. W. S. ANNOUNCES PROGRAM FOR SPRING MEETING

Announcement has been received that the annual meeting of the American Welding Society will be held at 33 W. 39th Street, April 25, 26 and 27. The tentative program of the sessions is as follows:

WEDNESDAY, APRIL 25, 1928

Committee Meetings

All Members of the Society are Welcome to these meetings.

MORNING

Pressure Vessels Committee, E. H. Ewertz, Chairman.

9:30 a. m. to 12.

Presentation of Procedure Specifications to be followed in making the tanks and specimens called for in the program of the Committee. Review of cooperation expected.

AFTERNOON

Structural Steel Welding Committee, J. H. Edwards, Chairman.

2:00 p. m. to 5 p. m.

A review of progress made to date. Reports of assignments, etc.

THURSDAY, APRIL 26, 1928

MORNING

Technical and Business Sessions

9:30 a. m. to 10:30. Business meeting. President's Report.

Report of Tellers Committee. Election of Officers.

10:30 a. m. to 12:30. Technical Session. Welding the Ford Car.

LUNCHEON

A luncheon for members of the Society will be arranged at the Engineers' Club. Tickets at $2.00 each may be obtained from the Secretary.

AFTERNOON

Technical Session

2:00 p. m. to 5. Room

Procedure standardization in welding. Qualifications of welders, inspection and supervision.

Report of Committee. H. H. Moss and A. M. Candy.

General discussion of above subject.

(a) Structural Steel. J. H. Edwards.

(b) Pressure Vessels. A. O. Miller, Reeves Bros. L. H. Burkhart, Struthers-Wells Co.

(c) Pipe Welding. A. W. Moulder, Grinnell Co.

EVENING

ANNUAL DINNER

The dinner this year will be arranged as a stag affair.

FRIDAY, APRIL 27, 1928

MORNING

Board of Directors

9:30 a. m. to 12. Room

Meeting of the Board of Directors, American Welding Society. Appointment of Committee Chairmen and other Officers. Committee reports. Discussion of sections' activities. Plans for the coming year.

AFTERNOON

Annual Meeting

American Bureau of Welding

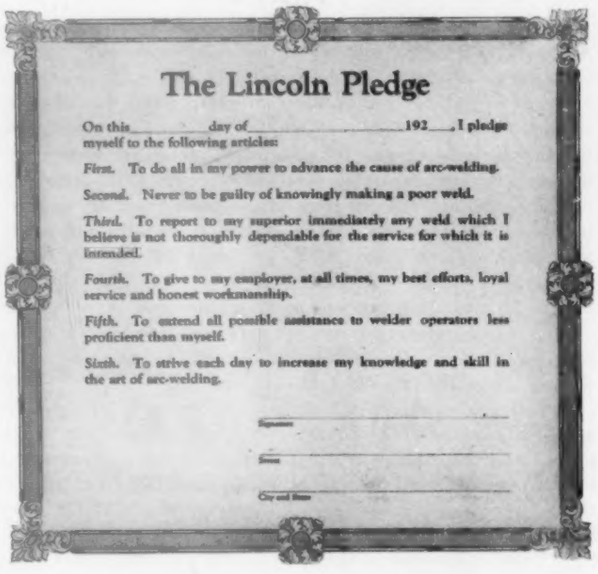
2:00 p. m. to 5. Room

Review of progress made by various research committees of the Bureau. Plans for future investigational activities.

Election of officers. Executive Committee.

LINCOLN ASKS OPERATORS TO SIGN PLEDGE

The Lincoln Electric Co., Cleveland, Ohio, published monthly a bulletin for operators called the Stabilizer. That this little publication is largely read by arc welding operators is evidenced by the number of operators' letters in each issue both asking for information and volunteering information regarding arc welding problems. In the February issue of The Stabilizer, there was inserted an extra sheet on which was printed the pledge shown in the accompanying illustration, and the Lincoln Electric Co., in its bulletin indicated that a certificate signed by officials of the



The Lincoln Pledge

On this _____ day of _____ 192___, I pledge myself to the following articles:

First. To do all in my power to advance the cause of arc-welding.

Second. Never to be guilty of knowingly making a poor weld.

Third. To report to my superior immediately any weld which I believe is not thoroughly dependable for the service for which it is intended.

Fourth. To give to my employer, at all times, my best efforts, loyal service and honest workmanship.

Fifth. To extend all possible assistance to welder operators less proficient than myself.

Sixth. To strive each day to increase my knowledge and skill in the art of arc-welding.

Signature _____

Street _____

City and State _____

company would be forwarded to all welders who signed this pledge. It is obviously intended to inspire pride of workmanship and ambition to raise the standard of workmanship in the industry. Mr. A. F. Davis, Vice-President of The Lincoln Elec. Co., states that a large number of these pledges were received almost by return mail and that they are still coming in. He also says that a number of employers have been heard from who feel that the pledge idea has had a considerable influence in getting men to take more interest in the quality of welding which they do.

R. B. MALM TALKS TO CHICAGO SECTIONS

At the March meeting of the American Welding Society, Chicago Section, which was held on the evening of March 2nd, Mr. R. B. Malm, Chicago district manager of The Lincoln Elec. Co., read a paper on the use of arc welded steel for the replacement of castings and riveted construction. The talk showed the comparison between welded steel and cast iron in machinery construction from an engineering standpoint, and lantern slides showed a great many examples of where the substitution has been made in such a way as to result in an improvement of the product and an actual saving in the production cost. Following the showing of the lantern slides there was a lively discussion of a number of the points brought out by the paper.

CORRECTION

In the report on the conference on welding which was held at North Texas Agricultural College, Feb. 7 and 8, published in the February issue of *The Welding Engineer* the confusion of several lines of type resulted in mixing up the names of authors and papers. The paper on "Application of Arc Welding to Pipe Lines" was read by Mr. Rickel, of The Big Three Welding Co., Ft. Worth, Texas. The paper on "Manufacture and Uses of Carbide" was read by Mr. Ackerman, of the Air Reduction Co., New York City, and the paper on "Training Men for the Welding Industry" was read by Mr. M. C. Stone, of the Engineering and Trades Department, North Texas Agricultural College.

Practical Studies of Electrodes*

Various Factors Which Determine the Suitability of a Metallic Electrode from the Standpoint of Weld Quality and Flowing Characteristics

by Kenneth R. Hare†

PART I

FUSION welding has become so well known during the past few years, that it is perhaps unnecessary to define what is meant by a welding rod. However, for the benefit of those who are not entirely familiar with the process, it should be pointed out, that when two parts are being joined by fusion welding, some additional metal is generally required. Additional metal is always required in metallic arc welding, but not always required in carbon arc or oxy-acetylene welding. This additional metal is usually furnished in the form of a rod from 14" to 36" long and from $\frac{3}{32}$" to $\frac{1}{8}$" in diameter, which is commonly known as an electrode in the electric arc welding process or as a filler rod or welding rod in the oxy-acetylene process. These rods may be either cast, rolled or drawn. For automatic electric welding the welding wire is generally furnished in coil form on reels.

It will be the object of this paper to discuss the importance and composition of welding rods for the electric welding process only, although many of the remarks concerning wire for arc welding, will also apply to oxy-acetylene welding. We shall endeavor to show the importance of using the proper grade of electrodes for the different classes of work and to show what chemical and physical properties may be expected in the weld when using electrodes of different analysis. This is intended to be a practical discussion, rather than a highly technical one.

In general, an electrode may be considered as satisfactory if it will produce a weld which has the desired physical properties and which will, at the same time, have good flowing qualities. By flowing qualities we mean a quiet, clean, smooth action in the arc without undue splattering and with good penetration and fusion. In fact, proper physical properties are difficult to obtain, unless the electrode flows properly. In addition, of course, the electrode must be economical as to first cost and welding speed and it must be uniform so that consistent results may be expected after a definite procedure has been established.

The physical properties, which are desired in the weld, depend on the service requirements. The first requirement of a weld is that it be sound and free from blow-holes, slag and oxide inclusions. The second requirement has to do with the physical properties desired, such as tensile strength and ductility or hardness, as the case may be. Therefore electrode material and method of use must be such that both of these requirements will be fulfilled.

The reasons for a careful choice of the proper grade of electrode are the same which govern the choice of proper grades of steel for the different parts of machinery, automobiles, tanks, buildings, boilers, etc. As fusion welding is becoming so generally used in all industries, it becomes more and more important, for those who are directing the use of this process, to give careful and intelligent consideration to the choice of the proper grade of electrode for each particular application.

Until recently it was considered good practice, if a welding rod was chosen which would produce a deposit as good as the base metal being welded upon, but recent developments in electrodes (and this is also true in oxy-acetylene welding) have made it possible to choose an electrode which will produce a weld having physical properties even superior to the base metal. This is particularly true in building up operations, where a Chrome Vanadium Alloy is successfully applied to the worn surface of a steel rail, or where high manganese steel is applied to the worn ends of high carbon wobblers in steel mills. In all of these considerations, however, it should be remembered that the metals being joined or built up by fusion are usually rolled plate or forgings while the metal being deposited from the welding electrode is always in the cast condition. The physical properties, which may be desired in the finished weld, regardless of whether it is strength, ductility or hardness, are determined, to a great extent, by the analysis or composition of the electrode.

It is also possible to control, to a certain extent, the analysis and therefore the physical property of the deposit, by providing the electrode with a special flux coating which may include certain alloy elements. The coating also acts as a flux to prevent loss by oxidation of the elements already in the rod. It is perfectly possible to introduce carbon, chromium, nickel, manganese and other important elements into the deposit by incorporating these elements in the flux coating on the rod itself, which may be ordinary mild steel. There are numerous electrodes on the market which produce alloy steel deposits by this method. Steel rods, which are nickel or chromium plated, are used in the same way to produce alloy deposits.

The physical properties of the weld are also determined by the manipulation of the rod by the operator, or in other words by the welding technique. If an electrode containing high carbon, is used with negative polarity, more of the carbon is lost, or oxidized, than is the case when the electrode is used positive. The following tests were made to show the influence of polarity on the use of high manganese steel:

	Wire Electrode	Electrode Neg. Deposit	Electrode Pos. Deposit
Carbon	.85	.63	.83
Manganese	11.2	8.11	8.11
Phosphorus	Not determined	0.034	0.032
Sulphur	" "	0.010	0.012
Silicon	.....	.....	.....

It will be seen that more of the carbon was lost with negative polarity than with positive polarity. The manganese does not seem to be affected by polarity but its value in the alloy is determined by the amount of carbon present. It is therefore apparent that positive electrode polarity should be used when welding high carbon and high manganese steels.

Another effect, which is under the control of the operator and which may be considered as part of the welding technique, is that produced by heat treatment in some cases. For instance, when depositing manganese steel by welding, it is the recommended practice to quench the red hot deposit with cold water except on relatively heavy sections where the sudden cooling is affected by heat absorption. This sudden cooling toughens the deposit and produces a very desirable change in its physical properties. This procedure is simply following the standard method used when manufacturing the original manganese casting, which is plunged into cold water

*A paper delivered before the University of Wisconsin Welding Conference, Madison, Wis., Feb. 8, 9 and 10, 1928.

†Sales Manager, C. H. Hollup Corporation, Chicago.

while at a temperature of approximately 1800° Fah. If it were not for this sudden cooling, the high manganese steel casting would be very brittle and would not stand the pounding and other excessive strains to which it is subjected when in service. Thus, the sudden cooling, which produces brittleness in ordinary high carbon steels, produces ductility and toughness in manganese steel.

We now come to the flowing characteristics of the electrode, which we consider to be of the greatest importance. A sound weld cannot be obtained unless the electrode has good flowing qualities. No matter how careful the welder may be to choose the proper electrode, as regards composition, if he cannot use this electrode satisfactorily, and if it does not flow and fuse in such a manner as to produce soundness in the weld, it would have very little value as a welding rod.

Flowing qualities of a welding rod, for electric welding, are dependent upon four factors:

COMPOSITION
PHYSICAL STRUCTURE
SURFACE TREATMENT
GAS CONTENT

By "Composition" we mean the chemical analysis; by "Physical Structure" we mean the condition of the material as brought about in the manufacture of the steel in the furnace and also in its subsequent casting, rolling, drawing and different degrees of annealing; by "Surface Treatment" we mean whether it is bare, processed or flux coated and by "Gas Content" we refer to occluded gases, such as Hydrogen, Nitrogen and Carbon Monoxide, which are always present in steel in solution.

In regard to the composition, and its effect on the flowing characteristics, it may be of interest to point out that up to about .40 carbon, the electrode must be used with negative polarity, but when the carbon content is higher than that, it must be used with positive polarity, in order to flow properly. This phenomenon in electric arc welding has never been satisfactorily explained and should form the basis of some very interesting research work.

Another effect of composition on flowing charactertistics, is the opinion held by many operators that an electrode, having a carbon content of between .08 and .18, welds easier overhead than one having a carbon content less than .08. It certainly is true that carbon up to .18 seems to improve the flowing qualities of an electrode, whereas carbon in excess of that amount is detrimental to penetration. This is probably due to the effect of the lower melting point of the higher carbon steels. Flux coating and using positive polarity on the electrode greatly improves the flowing of electrodes high in carbon.

In general, it may be said as regards soft annealed and hard drawn electrodes, especially of the low carbon type, that those which are soft annealed flow a little faster and do not penetrate as deep. They, therefore, should be used in production work on thin sheet metal, where it is desired to produce the maximum amount of welding possible in a given time with minimum heat. This soft annealed electrode, however, is not well adapted to welding on vertical surfaces or overhead so that for a general all around electrode, it is not as good as the hard drawn type.

The occluded gases in steel electrodes, which are chiefly, Hydrogen, Nitrogen and Carbon Monoxide, have a greater effect on the qualities of an electrode, than was formerly supposed. The influence of these gases is noticed in two ways; first as regards their effect on the arc characteristics and second as they affect the composition and structure of the deposited metal. Their effect on the flowing qualities is probably due to the sudden expansion and release of these gases, causing a wild sputtering arc. Their effect on the composition of the deposit may be brought about by the retention of some of the gases in the weld, either in the free state or in combination with the iron or other elements present. The structure of the deposit is influenced by the instantaneous release of dissolved gases at the moment of solidification of the metal.

We now come to the effects of surface treatment, or processing, as it affects the flowing characteristics of the electrode. It is well known that, occasionally, some electrodes are found, which have not had any specified surface treatment, but yet have good flowing qualities. It is becoming recognized, however, that such material is not commercially obtainable with any satisfactory degree of uniformity. To insure uniform satisfactory flowing qualities in an electrode, regardless of composition, it is now generally conceded that the wire, or rod, must be given some special surface treatment or processing in order that it may produce sound welds. This is true because, as previously stated, soundness in a weld is dependent on the flowing qualities of the electrode.

Broken Engine Frame (Above) Before Welded, and (Below) After Electrically Welded. Careful Choice of Filler Material Is Essential on Work of This Class.

The character of the surface treatment, which is given the different grades of electrodes, is governed by the composition of the rod and by the results desired. In some compositions only slight treatment is necessary to produce satisfactory flowing qualities and good fusion. In other compositions, a very special treatment of the surface of the electrode together with a very special welding technique is necessary to produce the desired result.

For instance, commercially pure iron or low carbon mild steel, which has been carefully made, and which is of uniform and sound physical structure, requires only a slight amount of surface processing to produce uniform flowing characteristics and satisfactory fusion. Even this slight amount, however, is necessary in order to obtain the desired degree of uniformity. On the other hand, the high carbon

electrodes, or some of the alloy electrodes containing high carbon, require special surface treatment or coating in order to produce good flowing qualities and proper fusion as well as soundness. High carbon steel electrodes, in general, form gas during welding, which may cause an unsound weld by the formation of blow-holes, etc. In the manufacture of castings, it is of course, standard mill practice to introduce deoxidizers and de-gasifiers to minimize blow holes and other imperfections. The same result is accomplished in welding by using similar elements in the composition of the rod itself, or in the form of a flux coating. This latter method, not only stabilizes the arc, but prevents the formation of objectionable gases and possibly the absorbtion of atmospheric gases.

The proper surfacing, or coating, of an electrode also has a considerable effect upon its speed, without any sacrifice in flowing qualities. Generally when the current is increased beyond the normal range for bare electrodes, the arc becomes wild and a great deal of metal is thrown off by spattering or sparks. This does not refer to the wild erratic arc caused by magnetic disturbances. By using the proper flux coating the arc is quieted down even though an excess of current is used with the result that the electrode melts much faster and more pounds per hour are deposited. This is particularly true of the larger sizes, including $\frac{5}{16}$" and over. The increase in speed of the ordinary flux coated electrode, when considering sizes of $\frac{1}{4}$" and less, is not so pronounced, although it is still some greater than the speed of equivalent sizes of bare wire. Some highly specialized flux coatings, or flux bearing electrodes, have been developed for speed purposes only.

Uniformity is one of the most important qualities that an electrode can have. By this, we mean uniformity of composition and uniformity of operation. We suggest that the safest and most reliable method of obtaining uniform welding rods is to purchase them from a reliable manufacturer by brand. The brand which best meets the purchaser's requirements can be chosen by a proper laboratory and service test.

We have already pointed out that even though an electrode has the correct chemical composition, it still may be unsuited for welding purposes. The difference between a good and poor electrode is generally determined by special manufacturing practices which are carefully followed only by certain specialists. An electrode, and in fact all welding wire, should be considered as a specialty and it should be realized that only those manufacturers who make a specialty of welding rods, are suited by experience and necessity to give this material the careful attention it must have.

We are going to take this opportunity to mention one point in connection with the testing of welding wire, which should always be given consideration. This is, the tensile strength of the test piece made by welding, is influenced to a considerable extent, not only by the composition of the wire, but also by the rate of cooling. Therefore a test sample made by a $\frac{1}{8}$-inch electrode on a 1-inch plate, will ordinarily show a higher tensile strength than a similar test made by a $\frac{5}{16}$-inch electrode on a $\frac{1}{2}$-inch plate. The general rule would be to use the same thickness of plate and the same size electrode as will be used in actual service. The best test samples for determining the physical qualities are those turned out of a pad of deposited metal.

In practice the effect of sudden cooling is generally a disadvantage. For instance in welding up a crack in a locomotive fire box, if a $\frac{1}{8}$-inch electrode is used to run a small initial bead, the chilling action will produce cracks. These cracks may be avoided if a larger rod is used and the weld filled up with one layer.

The cost of the welding operation is determined by the first cost of the electrode, the size of the electrode used, its characteristic speed, the labor cost and the cost of electric current. Of these factors, the labor cost is the most important in the majority of cases because the operator's wage per hour is generally several times as great as the value of the material he uses. As the labor cost in electric welding is dependent on the time taken to do the job any method of reducing this time provides the most effective way of reducing welding costs. The rate of electrode deposit in pounds per hour varies greatly with the different sizes and the choice of the proper size is therefore the most important factor of cost under the control of the operator.

In order to effect the greatest economy, the largest size of electrode applicable to the work should be used. The reason for this statement is that in general the larger the electrode the greater the number of pounds per hour deposited. As the pounds per hour are increased the cost of the job is reduced. The following table most effectively shows the great importance of using the larger sizes of electrodes wherever possible as regards welding economy. It is an abstract of an extensive test made by one of the larger steam railroads to determine the actual cost of electric welding under service conditions.

Size of Electrodes	Pounds used per hour	Total cost per pounds used
1/8 "	.68	$1.55
5/32"	.77	1.40
3/16"	1.33	.85
1/4 "	1.93	.63

The above results include all cost relating to material, labor, supervision and overhead. They are also based on an average productive time of only 55 per cent, which is perhaps lower than would be considered normal in the average industrial plant. The main value of the test, however, is not in the actual values, but is in the relative values shown for the different sizes of electrodes. For instance, if the user of the electric welding process consumes 100,000 pounds of electrodes per year which average $\frac{3}{16}$ inch in size and by proper supervision he increases this average to $\frac{1}{4}$ inch he would save approximately 55 cents per pound of electrodes used or a total of $55,000.00 per year.

OXYGEN FINDING MANY NEW USES IN INDUSTRY

While the greatest industrial use of gaseous oxygen is in the cutting of metals with the blow pipe, a constantly increasing number of applications calls for the production of millions of feet of oxygen annually other than that used in cutting and welding.

In the manufacture of ferro-alloys, the use of an oxygenated blast increases the output of the furnace. Where low-cost oxygen is available, it is commercially possible to produce SO_2, for use as a refrigerant, by the combustion of pure sulphur in pure oxygen. Air enriched by oxygen to a 50-50 mixture gives better yields of nitrogen dioxide in the arc process of making nitric acid. Oxygen is further utilized in producing cheap alcohol by fermentation of wood cellulose, the manufacture of synthetic methyl alcohol from methane, and the manufacture of formaldehyde from acetaldehyde, ethylene or methane.

In the *General Electric Review* for December, F. P. Wilson, Jr., manager's staff of General Electric Company, describes the production and characteristics of oxygen, and suggests several uses for the element in addition to those mentioned. The commercial possibility of a number of these applications depends, however, upon the production of cheaper oxygen than is now obtainable.

Mr. Wilson points out the economies that could be effected by the use of oxygen in the production of water gas, Bessemer steel, and other important industrial materials, and in iron-smelting, and he states that "oxygen is rapidly becoming as essential to industrial life as it is to human life, and as new applications are economically perfected it will undoubtedly rank with other forms of industrial utilities such as light, heat and power."

Welded Aluminum Tops for Buses

Analysis of Requirements of Complicated Design Leads to Welding as Only Practical Production Method

by L. R. McKean*

NO longer will those who ride the upper decks of the P. R. T. buses in Philadelphia shiver from the cold or cringe from the raindrops. The conventional open headways are now being fitted wih neat covers, permanently attached, thus eliminating the discomforts of the elements.

The complete covers shown in Figure 1, are made of sheet aluminum. In the fabrication of the front and rear sections, it has been found, after a study of various possible methods of assembling, that gas welding is not only most satisfactory but is necessary in order to carry out the original design.

The job is being handled by the Electric Service Supplies Company, of 17th and Cambria Streets, Philadelphia. At the time they received the order they had had no experience with sheet aluminum welding. In fact, welding was not considered as a necessary operation until all of the requirements of the job had been analyzed and welding had presented itself as the only practical solution of the difficulties encountered.

In the construction of the front and rear sections, Figures 2 and 3, it became apparent that these parts could not be economically or efficiently drawn or pressed from the sheet as planned. This was due to the depth of the draw, complication of design, excess of metal at corners and high expense connected with the construction of the necessary dies.

With drawing or pressing eliminated, it was decided to make cutouts from the sheet aluminum, shape the cutouts over suitable forms and weld the seams. Welding, however, presented a new difficulty, for as stated before aluminum welding was entirely new to this company. For assistance on this a welding engineer was called in for advice and for instructing the welders in the new work.

The sheets are cut out as shown in Figure 4, the cutting being done with a saw. Several sheets are cut at the same time. These cuts are figured so close that trimming is in most cases unnecessary in the forming operation.

The forms are of cast iron and at certain points inserted pins fit in holes punched in the sheets. This is a precaution to prevent the sheets slipping and to insure uniformity in shaping. Some hammering is necessary to get the desired shape and clamps are used to retain the shape, as shown in Figure 5, until all seams are tack welded.

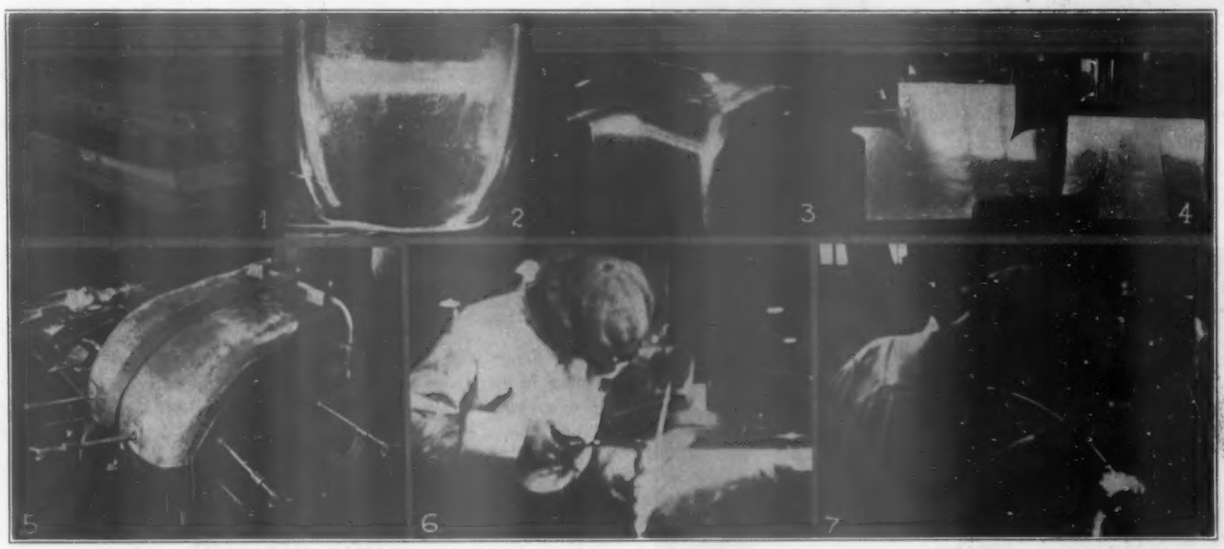


Fig. 1.—Double Deck Bus Fitted With Welded Cover. Fig. 2.—Front Section of Cover at Finish of Welding Operation. Fig. 3.—Rear Section. Fig. 4.—Sheets Cut For Shaping Into Front and Rear Sections. Fig. 5.—Seams Tack Welded While Section Is Clamped to Cast Iron Form. Fig. 6.—Tack Welding the Seams. Fig. 7.—Welding a Seam.

The tack welds are about one and a half inches apart (see Figure 6) and when all seams are properly tacked the part is removed from the form for the seam welding operation.

A filler rod is required for the seam weld, Figure 7, and practically no reinforcement is given. Penetration is excellent, a distinct bead showing on the under side of the weld seams, Figure 8. As a filler material, narrow strips cut from scraps of sheets are used. This was adopted after trials with regular aluminum welding wire showed difficulty in fusing and defects in the weld.

After various makes of flux had been subjected to tests in practice, one supplied by the Aluminum Company of America was found to give very satisfactory results. The flux was dissolved in water and painted on the carefully cleaned filler strips and weld areas.

Both acetylene and hydrogen are used as fuel gases, the

Welding Specialist, Charles Bond Company, Philadelphia.

choice of gas being left to the welder. The torch used is Model 1-NF Torchweld.

There are no welds in the middle sections of the covers, Figure 9, as it is a simple operation to shape them from the sheets. These sections are fitted wih adjustable ventilators in each side. The proper use of clamps and jigs insured accuracy of dimensions, so that the finished covers fit perfectly except in the cases of some buses whose bodies have been distorted slightly from road shock and vibration. However, this was not so much as to make the fitting especially difficult.

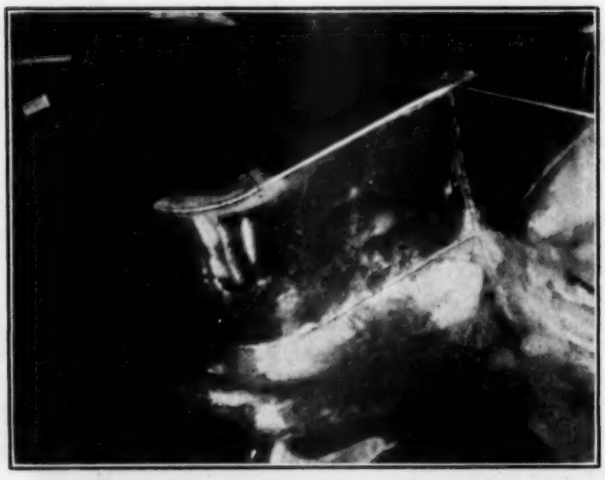


Fig. 8.—Underside of Weld Showing Excellent Penetration.

Worthy of note in this case is the fact that the manufacturer is now exceeding the contract production schedule on this job, with some phases of which he has not yet had a month's acquaintance. In all, it well proves how welding can often be made a production manufacturing operation on very short notice.

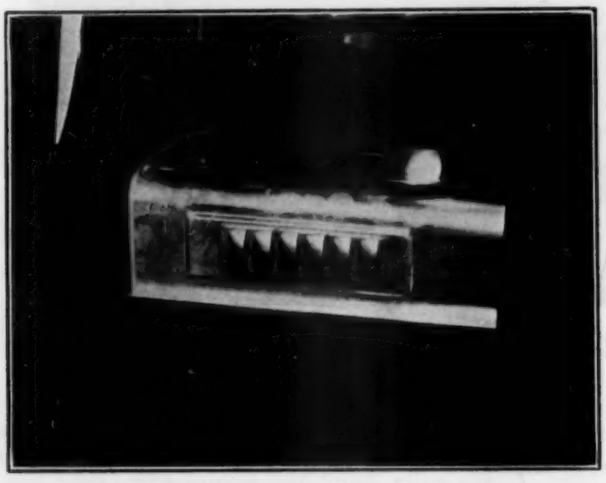


Fig. 9.—Middle Section, Fitted With Ventilator

THOROUGH TREATISE ON ALUMINUM AND MAGNESIUM BY BUREAU OF STANDARDS

In response to the increasing demand for information concerning the manufacture and properties of metals and alloys, the Bureau of Standards has undertaken to issue from time to time circulars on individual metals and alloys, including all of the best information available through the bureau's own tests and investigations or through published tests and research conducted by others.

One of the latest bulletins issued in this series is a 400-page volume on aluminum and magnesium and their alloys, dealing in thorough manner with their metallurgy, metallography, chemical and physical properties, and the technology of working the metals, as in machining, casting, soldering and welding. There are several references to welding of sheets and castings, of commercial aluminum and duralumin, and also of magnesium, including information on the effect of heat treatment, chemical composition of several aluminum fluxes, and a bibilography of aluminum welding literature which includes about 150 references to books on the subject and articles in American and foreign engineering journals.

This bulletin can be secured for the price of $1.10 from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C.

WELDING SOCIETY TO HOLD JOINT MEETING WITH CIVIL ENGINEERS

Announcement has been received of a joint meeting of the American Welding Society, New York Section, and the American Society of Civil Engineers, New York Section, to be held Wednesday evening, March 21, at 8:15, in Room 1, Engineering Societies Building, 33 W. 39th St., New York. The program will consist of the reading and discussion of the two following papers:

ARC WELDED BUILDINGS AND BRIDGES

By GILBERT D. FISH, *Consulting Structural Engineer*

The subject matter will cover types of structural joints, basic design calculations for structural arc welds and construction methods used on two buildings and three bridges. These structures will be illustrated by lantern slides.

OXY-ACETYLENE PRACTICES OF INTEREST TO CIVIL ENGINEERS

By C. A. DALEY, *Maintenance of Way Engineer, Air Reduction Sales Company*

The paper will touch upon the high points of gas welding and cutting in civil engineering field with special reference to building up worn rail ends, repair of frogs and switches, welding of power plant pipes, replacement of bridge members, maintenance of bridges and excavating machinery, etc., demolition of bridges and steel structures.

BOOK REVIEW

The Manufacture of Carbide of Calcium (new and revised edition) by Charles Bingham, C. E., and C. H. Bingham (Junr.) is now ready, and can be obtained from the offices of The Welding Journal, 30 Red Lion Square, London, England. The price is 15 shillings. Its publication has been unavoidably delayed for various reasons, not least of which has been the illness of both authors and the publisher.

Being a new edition, the book follows very closely on the lines of the first. It has been thoroughly revised and brought up-to-date. Both authors are exceptionally well qualified to write on this subject, as Mr. Bingham, senior, has the distinction of having been managing director of, or consulting engineer to, the Calcium Carbide Factories at Notodden, Thornhill, Cordoba, Mexico City, etc., whilst Mr. C. H. Bingham, junior, was the designer of the Calcium Carbide Factories at Manchester, Ballengeich, Collooney, etc.

The authors deals with the manufacture of carbide of calcium in all its aspects—historical, chemistry, manufacture, transport, testing and quality. The illustrations are ample and the index will be found especially useful.

The new edition is printed on first-class paper, with three plates and numerous illustrations and is fully bound in linen cloth

Studies of the Welding Arc*

Phenomenon of Electric Arc Analyzed from the Standpoint of Its Application to Welding. Principle of Atomic Hydrogen Process Explained.

by P. Alexander†

Synopsis.—The subject of this paper is a phenomenon of great interest and very great complexity. The electric arc is a tool of extreme power and flexibility. The electric arc can be used to melt the most refractory substances, cut the armor plates of battleships or weld together the ends of wires no thicker than a human hair. It is a wonderful tool that makes or breaks almost anything. It may unite the most indifferent elements such as nitrogen and oxygen, or break the molecule into its constituent atoms.

In this paper we shall discuss only one type of application of the electric arc; namely, the application of the arc to the welding of metals, but even in these limits the field is very wide.

The electric arc was discovered by H. Davy who in 1810 was experimenting with the sparking between two horizontally disposed carbon pencils. The density of the current was such that on short circuit the tips of the carbon pencils were heated to incandescence. When the electrodes were separated the electric current continued to flow across the air-gap between the carbon pencils. The air-gap was bridged by some sort of an extremely bright band which under action of the ascending currents of hot air was bent upwards and formed a bow or an "arc." This is the origin of the term, the "electric arc."

For many years the electric arc was used only as a source of light. It was only years later that the electric arc was applied for the purpose of melting and welding metals together. In 1881 de Meritens for the first time used a small carbon arc for melting and welding the lead terminals of storage batteries. The more extensive application of the carbon arc was done by Bernardos.

This process was modified by Dr. Zerener of Berlin, Germany, who shortly prior to 1890 invented a process of welding with a flaming arc. In this process two carbon electrodes are disposed to form a "V". The arc is drawn between the two electrodes and caused to impinge upon the metal to be welded by being forced down by a powerful electromagnet. This arrangement caused the arc to act in a similar manner to the flame of an oxy-acetylene flame. The energy developed in this arc is only partly transmitted into the weld and the efficiency of the method is very low.

The third type arc welding known now as a metallic arc process was discovered about 1890 by H. Slawianoff.

This engineer conceived the idea of producing steel ingots by an electrical casting process. Metal was depositd from a steel rod into a mold, an electric arc being maintained between the rod and the metal of the mold. Means were provided wherby the metal rod could be fed forward as it was consumed and a solenoid arrangement was provided for maintaining the arc length substantially constant. The ingots obtained under such conditions proved to be sound and free from shrinkage pipes. However, the cost of electrical energy in Russia in those days was very high and the process was commercially uneconomical.

The information obtained by Slawianoff in this work led to the application by him of the metallic arc to the uniting together of metal plates, the repairing of cracked and broken machines, etc.

Thanks to the work of Slawianoff we now possess a method of welding with metallic electrodes which at present is by far the most used of all arc welding processes.

Electric Arc

THE metallic welding arc is a phenomenon of great complexity. It is a combination of three distinct features; namely, conduction of the electric current, melting of the plate and deposition of the metal from the rapidly melting electrode. The first feature in itself is a complicated phenomenon, which can be understood better if we consider it after reviewing the accepted ideas on electric conduction in solid conductors and in vacuum tubes.

The electric current flowing through the solid conductor has been demonstrated by the experiments of Talman and Stewart to consist wholly of electrons. The positive ions form a rigid frame-work and participate only in the vibratory movements due to the thermal agitation. The whole space is occupied by the spheres of action of the atomic forces. And between atoms there is a continual exchange of the electrons. At any instant there is a number of electrons in transition from one atom to another. These dartings from one atomic system into another are especially numerous in good conductors, and the electrons which during that short fight do not belong to any atomic system are termed free electrons. In the absence of an electromotive force, these movements are equally distributed in all possible directions, and the resultant of those elementary currents is zero. When a difference of potential is, however, impressed on the conductor, these disorderly migrations acquire a certain orientation so that more electrons will be moving in the direction of the positive pole.

An idea of the number of moving electrons may be obtained if we will try to visualize the number 1.6×10^{19} which represents the number of electronic dartings during one second through the cross-section of the conductor when it is carrying a current of one ampere. However great this number may seem, it is not the total number of electronic dartings but only a difference between those directed towards the positive and negative poles.

The conduction through the space not occupied by the solid conductor is electronic only in case of extremely high vacuum. In this case the electrons shoot from the cathode in straight lines across the empty space or through the comparatively few molecules present which in extremely high vacuum can be in the order of a hundred million per cubic centimeter. Since the molecules themselves are mostly an empty space with a few specks representing the central nuclei and outer electrons, the high speed electrons can shoot through them without being stopped or deviated.

The voltage necessary to produce such electronic currents would be of the order of millions of volts and the obtained currents expressed in milliamperes. In other words, for most purposes a space not occupied by either solid or gas of sufficient density is an insulator. There will not be any change in conductivity if a gas in a perfectly neutral state be introduced between the electrodes. The distances between the gaseous molecules, even if their number is increased to several billion of billions per cubic centimeter, are relatively so great that there cannot be any exchange of electrons as in solid conductors between the atoms and the space remains non-conductive. This, however, will cease to be so if the molecules acquire electrical charges.

Under usual conditions gases are subjected to various ionizing radiations such as the radioactivity of the earth, ultra violet rays and the electrons emission from the hot bodies and flames. In atmospheric air these factors determine a generation of two to three ions per second per cubic centimeter. However small the degree of ionization may be, the gas will always contain a few ions and free electrons. If an electron moving with sufficient velocity encounters or passes very near one of the outer orbital electrons of an atom, the repulsive forces between them may be such as to detach the orbital electron from the atomic system, which then remains with a unit positive charge. The removed electron may either repeat the same process with the next molecule or attach itself to it, thereby communicating a negative charge. This removal or attachment of one extra electron to the neutral molecules is called "simple ionization."

Ionized atoms or molecules will also start moving in the direction of the electric force and if the potential gradient is sufficient, will acquire such velocity that their impact on neutral molecules will ionize these. This process of cumulative ionization in a very short time will produce a sufficient number of carriers to transmit from one electrode to another a considerable current. Under certain special conditions, the highly ionized gas column may acquire an electric conductivity comparable with that of a good solid conductor. It might seem strange that a gaseous column can be almost as good a conductor as a copper rod, yet if we remember that the conduction depends only on the number of suitable carriers and on the velocity with which they can move this apparent paradox

Paper presented at a meeting of the Lynn Section, A. I. E. E., Lynn, Mass., May 18, 1927.

†*Thomson Research Laboratory, G. E. Co., Lynn, Mass.*

disappears. To pass now from gaseous conduction to arc conduction, we will consider the effect of the temperature of the cathode.

When the cathode is brought up by some means to a high temperature the electrons will be ejected from its surface into the gas in great numbers. These free electrons can be considered as ions and the gas containing such electrons as an ionized gas. The voltage necessary to move these free electrons towards the anode can be comparatively low. If the gas is at a very low pressure the electrons will move in straight lines between the molecules. Only a very few of these electrons will be stopped or deflected by collision with molecules. In this case the current will be purely electronic. However, when the molecules are present in larger numbers the electrons (if moving with sufficient velocity) will ionize the gaseous molecules and the current will be carried by ionized molescules as well as by the electrons.

The method of producing the intense initial ionization in the case of an electric arc is by taking an advantage of the property of certain materials to emit at high temperatures electrons which are projected in great numbers from the hot body into the surrounding gas. To draw the arc between the two electrodes, they are brought in contact and a current of sufficient magnitude is passed across the contact. The resistance of the contact, especially just before the moment of separation of the electrodes, is high enough to cause rapid heating of the tips of the electrodes to incandescence, with the result that numerous electrons are projected into the surrounding gas, so that at the moment of separation of the electrodes, the gas contains large numbers of free electrons which under the action of the established electrostatic field will move and impinge on the gaseous molecules.

Since the separation of the electrodes is done gradually, even with comparatively low voltages the potential gradient during the first moment will be sufficient to give the necessary accelleration to the free electrons which at the end of their free path will possess energy to ionize the gaseous molecules. The ionized molecules and electrons will move and impinge on the next neutral molecules but unless the potential gradient is sufficiently high, they will not acquire at the end of their free path a sufficient velocity and consequently will be unable to ionize the next set of molecules; therefore, the ionization will not continue. Since the distance between the electrodes continued to increase and the potential gradient to decrease, the current, after reaching certain magnitude, will fall to a lower value and finally stop altogether. But if the potential gradient during the separation of the electrodes be sufficient, the number of carriers will increase very rapidly until an appreciable current will flow between the electrodes which will produce rapid heating of gas. At higher temperatures the ionization occurs much more readily, so that as soon as the appreciable current flows, the ionization is more pronounced which again causes the current to increase. As soon as the cathode spot on the electrode is brought to a high temperature, a large volume of metallic vapor is sent into the stream which is easily ionized and will conduct practically the whole current. This is the arc conduction.

Since the drawing of the arc is done at a low temperature and the maintaining of the arc at high temperatures, the voltages necessary to strike the arc are always much higher than those used to maintain the arc. This feature is taken advantage of in the design of a number of commercial welding generators which produce a high voltage only on open circuit. As soon as the arc is drawn, the voltage across the brushes automatically falls to a value only slightly higher than that of the voltage across the arc.

Since high temperature is essential to maintain easy ionization, any factor tending to cool off the electrodes or the arc stream will influence greatly the stability of the arc. If the temperature of the arc falls, the ionization of the materials in the arc stream does not take place as readily, so that the agent producing ionization must be more active. In other words, the speed with which the electrons and ions impinge on the neutral molecules must be higher which necessitates a high potential gradient; that is, higher arc voltage. One of the most powerful methods of cooling the arc core is by surrounding it with hydrogen, which at high temperature dissociates into the atomic state and absorbs large amounts of energy.

Atomic Hydrogen Process

This phenomenon of dissociation of molecular hydrogen at high temperatures into the atomic state was discovered by Dr. I. Langmuir during his studies of the laws of heat losses from a heated tungsten filament in hydrogen at low pressures. Dr. Langmuir observed that above certain temperatures, the heat losses instead of being proportional to 1.9th power of the absolute temperature, are proportional to a much higher power which increases with temperature.

The following studies of this phenomena established that these abnormally high losses are due to the dissociation of molecular hydrogen into the atomic state. Step by step Dr. Langmuir discovered the temperatures of dissociation, degree of concentration of the produced atomic hydrogen, the energy absorbed by the dissociation, the chemical properties of the atomic hydrogen and the thermic effects produced by recombination of the atoms into molecules.

The atomic hydrogen possesses many remarkable properties which have been studied in the last few years by several investigators. Many chemical reactions impossible with molecular hydrogen take place when that gas is in the atomic state. The most stable oxides can be reduced into the metallic state. Substances which are usually considered as the most refractory materials can be melted by the flames of atomic hydrogen. And certain hydrogen compounds which formerly could be produced in very small concentrations, now may be obtained in 100 per cent concentrations. There are two methods of producing atomic hydrogen.

One discovered by Dr. Langmuir is by increasing the speed of the thermal agitation of hyrogen molecules until the forces between the two atoms composing the molecule are not sufficient to hold them together. They spring apart and by doing so absorb large amounts of energy from the source producing that thermal agitation. In this method all molecules subjected to the high temperatures are being acted upon simultaneously. This is (if we can use such a term here) a "mass production."

The other way of disrupting the hydrogen molecule is by hitting it with a heavy atom, moving with high velocity. In this method the hydrogen molecules are dissociated one by one and only when shot with a swiftly moving atom. Using again a shop term, we can call it a "piece work." However, Dr. Langmuir developed the first method which permits the production of atomic hydrogen in high concentration, which permits the use of atomic hydrogen not only as a special chemical reagent but also as one of the most remarkable agents for transmission of thermal energy. To accomplish this, it was necessary to produce the atomic hydrogen not inside of a vacuum container, but in the open air. The method adopted by Dr. Langmuir consists in blowing a stream of molecular hydrogen through an electric arc maintained between two tungsten electrodes.

The temperature of the arc core is sufficient to produce complete dissociation of the whole mass of the gaseous layer in contact with it. The produced atomic hydrogen diffuses rapidly away from the arc core and recombines in the cooler regions into the molecular state, forming an extremely hot flame of a single gas which burns without oxygen. The evolved heat, of course, is the energy previously absorbed from the arc. It was found that the heat of formation of molecular hydrogen is equal to 98,000 calories. In other words, when the

atomic hydrogen recombines to produce one cubic foot of molecular hydrogen (measured at N. T. P.), the amount of heat produced is 455 B. t. u. This quantity is greater than that obtained by the combustion of one cubic foot of molecular hydrogen in oxygen. In the last case the amount of evolved heat will be only 316 B. t. u.

The greatest advantage of the atomic hydrogen resides not in the amount of energy transmitted but in the high potential at which that energy is delivered. In other words, the remarkable property of the atomic hydrogen is the temperature of its flame. Dr. Langmuir's calculations show that this temperature is at least 3717 deg. cent. One of the experimental confirmations of these conclusions is the fact that tungsten, the metal with the highest known melting point, can be melted in the atomic hydrogen flame but not in any other flame.

The importance of the temperature of the flame can be illustrated by the comparison of two combustible gases; one of which is acetylene and another is propane. The amount of energy produced by combustion of one cubic foot of acetylene is 1456 B. t. u. The corresponding value for propane is 2465 B. t. u.

In spite of much lower heat capacity of acetylene, the temperature of its flame (over 3000 deg. cent.) is higher than that of propane (about 2100 deg. cent.) and the result of it is that the welding with that gas is much faster than with the latter.

One of the practical applications of the atomic hydrogen flame is for welding of metals.

In this field it has received lately numerous applications on account of its two properties especially valuable for welding work; namely, the extremely high temperature of the flame and the reducing properties of the gas forming that flame.

As a welding tool the atomic hydrogen torch must be compared with the oxy-acetylene torch. It has similar characteristics in that the most of the energy is produced in a comparatively small inner cone or fan where extremely high temperature is attained. This inner hot zone is surrounded by the flame of reducing gas with temperatures gradually falling to that of the outer mantle of the flame where the recombined molecular hydrogen is burning in contact with the air. The temperature of that part of the flame is something like 1000 deg. cent.

This gradual change of temperatures gives an extreme flexibility to the atomic hydrogen torch. It insures a perfect control of speed of welding and of the temperature of the molten metal in the weld. This last factor is of a paramount importance for welding in hydrogen atmosphere. This gas is only slightly soluble in molten iron just above the melting point. But with a rise of temperature its solubility increases very rapidly. When the molten iron is overheated, it will absorb at least 15 times its own volume of gas (measured at N. T. P.). During the solidification most of that gas will be precipitated out and unless special precautions are taken, will form numerous blow holes.

However, if the welder follows the right technic by forming only a shallow pool of molten metal which insures a low temperature of the molten iron, hydrogen will be prevented from going into solution and the resulting weld will be perfectly free from gas pockets.

The atomic hydrogen torch embodies in itself all the necessary conditions not only to transmit from the arc into the plate any desired amount of energy, but also to do it at a very high speed. The high speed of recombination of the atomic hydrogen into the molecular state is determined by the steep gradient of temperatures and also by the catalytic action of the metal in the weld.

This recombination of the atomic hydrogen at the surface of the liquid metal in the weld to a certain extent replaces the oxidation reaction always present when the welding is done in air. This reaction supplies the necessary auxiliary heat to keep the surface of the solidifying metal in the molten state long enough to permit the absorbed gases to escape freely.

The a-c. arcs used in the atomic hydrogen process are usually two or three centimeters in length bent in a shape of a fan between two tungsten electrodes placed to form a "V". The voltage drops at the surface of the electrodes; which correspond to anode and cathode drops in d-c. arcs, are equal to about 18 volts each. With the usual arcs of about 100 volts, the 36-volt drop at the surface of the electrodes, therefore, represents one-third of the total arc voltage, so that two-thirds of the energy absorbed in the dissociation of hydrogen into atomic state comes from the long arc core. The usual arc voltage is about 100 volts and the open circuit voltage of the welding circuit is seldom less than three or four times that value. The energy absorbed by the weld, of course, is that which comes from the arc; the atomic hydrogen plays the role only of an exceptionally efficient transmitter.

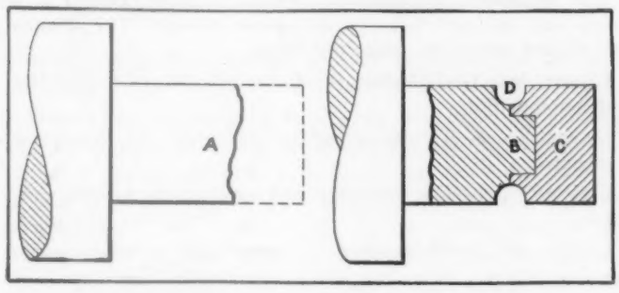
The energy evolved by burning the molecular hydrogen in contact with the air, serves only to raise slightly the temperature of the plate outside the weld but does not affect appreciably the weld itself. Most of that energy is radiated into surrounding space.

(This article will be concluded in the next issue.—Editor)

WELDING ROLLS IN SUGAR MILL

The following is from the November 7 issue of The American Machinist:

The first, Fig. 1, was a broken journal on the end of a crusher roll from a distant sugar mill. Since the pressure on these rolls runs up into the hundreds of tons, it is not surprising that they break occasionally. The method of repair is of interest. The broken journal end of the roll *A*, was turned down and faced as at *B*, and a piece *C* was turned up



Unique Design of Joint for Repairing Fractured Roll.

to fit on the end. This piece was shrunk on the end of the shaft and the space *D* was filled in by arc welding, being built up sufficiently to allow it to be turned down to the proper size of the shaft journal. The job was done in much less time than it would take to get out a new shaft, and time is the important element in the grinding season.

Another roll breakdown required entirely different treatment. The roll was a large one and the shaft had broken at the squared end where it fitted the hollow driver, or "muff," as it is called in the steel mills. The squared end measured 24-in. across the corners, and the largest shaft available was only 20-in. in diameter. But a little matter of four inches didn't phase Macfarlane of Sagua. Not while welders and electric current were on the job. He turned the body of the 20-in. shaft to fit the roll and built up the corners on the projecting end, as shown in Fig. 2, so that it fitted the driving coupling. The mill was only out of commission a few days.

ENLARGE LINCOLN SCHOOL FOR THE INSTRUCTION OF ELECTRIC ARC WELDERS

For many years past, a school of welding has been in existence in the plant of the Lincoln Electric Company, Cleveland, Ohio, but just recently it has been entirely reorganized and re-equipped. Its purpose is the training of electric arc welders; and though each individual instruction represents a considerable expenditure by The Lincoln Electric Company, no tuition or fees are charged.

In Figure No. 1 the equipment of the present school is shown. It will be seen that a number of standard 200 ampere "Stable-Arc" welders have been installed in line with a series of booths in which the pupils do their work. The new arrangement has been developed to simplify, as much as possible, the student's work in familiarizing himself with welding machines and practice. The welding unit that serves each man stands directly before the booth in which he practices. All the wiring

Left—Equipment of Lincoln Welding School. Right—Student Welder at Work.

except the necessary leads to the electrode holders is concentrated in conduit and the floor space is kept clear and clean. The individual compartments are curtained by heavy material so that there may be no chance of the arcs struck by other pupils flashing the men's eyes.

The course in the Lincoln Electric Welding School is a thirty day one and is given in twelve lessons. The lessons are divided under the following heads:

Lesson No. 1—The contact of the arc, its characteristics and manipulation.

Lesson No. 2—The nature of welding rods and depositing materials.

Lesson No. 3—The operation and care of the welding machine.

Lesson No. 4—The nature of vertical and overhead welding.

Lesson No. 5—Testing welds for porosity and strength.

Lesson No. 6—Welds on cast iron and their percentage of strength.

Lesson No. 7—The advantages and future of carbon arc welding.

Lesson No. 8—Welding of copper and bronze castings.

Lesson No. 9—The use and abuse of pressure welding.

Lesson No. 10—The assistance to the human element in "Stable-Arc" welding rod.

Lesson No. 11—The construction of welded machine tools.

Lesson No. 12—The simplicity and strength of welded fixtures.

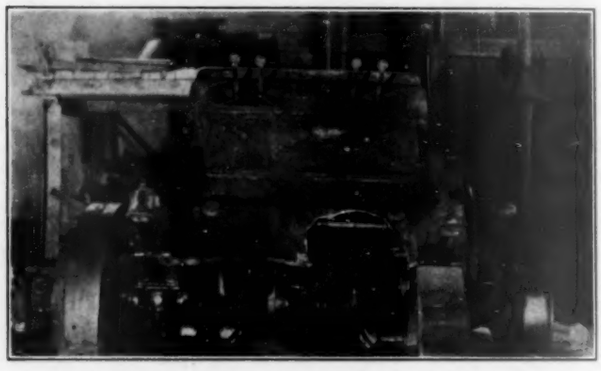
In Figure No. 2 a student welder is shown at work. Before him is the table on which he practices. At the time the photograph was taken he was welding a piece of scrap plate overhead as practice. You will see that though his equipment is of the simplest sort, it has all been arranged for his utmost convenience.

The construction of the table should be noted; it is entirely of welded construction. The angles supporting the practice piece of steel for overhead, turns in the pipe support so that it can be turned to meet the student's convenience. The holders for extra electrode are rather unique and consist of 2-inch pipe of about 6-inch length welded to the top of the table as shown in the picture.

The pupils in this school work under the direction of a trained instructor who teaches them both as a class and as individuals. All the educational work comes under the general direction of A. F. Davis, Vice President of the company. With thirty days intensive training, men are able to acquire a sound working knowledge of the fundamentals of electric arc welding, and are fitted to engage competently in the trade. The company does not maintain an employment bureau for graduates of the course, but the company does, if possible, fill such applications for men as are made to them, from the school.

TAKING PICTURES BY THE LIGHT OF A CARBON ARC

This picture of a welding job was taken by the operator by drawing an arc on a steel plate with 3/8-inch carbon electrode,



Photograph of Welding Job Taken by Light of Carbon Arc.

using a current of 200 amperes. The steel plate served to reflect the light onto the subject.

This picture was taken with an exposure of twenty five seconds. Welders who run across an interesting job will find this an effective means of getting a photograph of the work if there is not sufficient natural light at the location to get a clear picture.

PIPE WELDING JOBS WANTED FOR FILM

The Film Committee of the Gas Products Association, Chicago, has recently succeeded in completing the appropriation necessary for the production of a third reel of motion picture film on the subject of oxy-acetylene welding. It is the intention of the Committee to devote the entire reel to pipe welding. In order to get pictures of such work it is of course necessary to make plans well in advance of the operation, so the Committee has asked manufacturers and dealers in the industry to send word of any interesting pipe welding jobs which are to be done. Mr. E. L. Mills of the Bastian-Blessing Company, who is Chairman of the Committee, states that it is necessary to have notice of such operations some time in advance in order to make arrangements for getting cameras on the job, and although a location within a reasonable distance of Chicago is desirable as far as the Committee is concerned, it is not out of the question to make long trips to take pictures which would fit well into the proposed film provided there is sufficient time allowed to make the necessary arrangements. Information regarding future operations of this sort will be very much appreciated if forwarded to the office of the Gas Products Association, 140 South Dearborn Street, Chicago, Ill.

FACTORS INVOLVED IN ECONOMICAL GAS CUTTING*

By J. C. Anderson†

The first factor requiring consideration in the establishing of an efficient cutting department is the providing of proper equipment, and the effective maintaining of that equipment. Torches of a type suitable for the work should be on hand, together with tip sizes and styles to meet all conditions. The regulators should be capable of passing large volumes of oxygen at pressures suitable for the heaviest cutting. The hose should be of the very best quality to withstand the wear and tear to which it is subjected in work of this kind. The value of the oxygen wasted through a leaky hose will, in a very short time, exceed the cost of replacing with hose of good quality. Through rough handling such as using the torch as a pry to loosen the cut piece or as a hammer to knock off slag, the equipment is often abused to such an extent that only the most sturdy will pay for itself before being worn out.

The individual operator should be guided in the selection of tip sizes and oxygen and acetylene pressures for the various thicknesses and kinds of material to be cut. He should be urged to move the torch forward as rapidly as it will cut and at the same time produce a satisfactory surface.

Tip sizes and the proper pressures for operation will always be specified for various thicknesses and conditions. The approximate speed can also be established within close limits as a guide for the operator. The desired quality of surface can be established, and economy in oxygen consumption can be secured if sufficient attention be given these particular features. The selection of tip size and style governs, to a considerable extent, the quality of cut produced, and largely determines the pressure of oxygen and fuel gas used, and the speed at which satisfactory cutting can be accomplished.

Faster cutting can more often be done with small, suitably sized tips for the reason that the chilling effect is minimized and there is less induction of atmospheric oxygen and nitrogen into the cutting jet to dilute and contaminate the stream of oxygen.

The style of tip should also be given consideration, and in general it is safe to assume that one with multiple heating flames of small size is suitable for most cutting, except when the material is covered with a heavy refractory covering of rust, scale or paint, in which case larger preheating flames are desirable. The cutting tips receive severe abuse, and too much care cannot be exercised in maintaining their original perfect form and condition.

Tip sizes, pressures, speeds of cutting and quality of cut are so closely related and have such an important bearing on economy that we will consider them in greater detail. The establishment of a correct schedule of oxygen and gas pressures for the cutting of various thicknesses and grades of material is just as important as the insistance on the use of suitable tips. In fact, the specifications for tip sizes and oxygen pressures are so closely related that it is impossible to think of one without considering the other.

The lowest reasonable pressure of oxygen should be employed which will give satisfactory performance at economical speeds. High oxygen pressures are usually wasteful of oxygen unless the operator, by reason of extensive experience, can operate at a high enough speed to utilize the oxygen economically.

There can be no argument as to the influence of speed of cutting upon the cost of operation when it is recognized that with a given orifice and a constant pressure oxygen flows at a constant rate. It is, therefore, important that every effort be made to force the torch to cut at the greatest possible speed commensurate with the quality desired.

Frequently we find that speed is thought to be the most important consideration for the attainment of economical cutting, but we need only stop for a minute and compare the cost of the oxygen which will pass through a tip of given size in an hour with the hourly labor cost to see that the oxygen cost is a far more important factor. It may be of interest to note that the average ratio of oxygen cost to labor cost was 3.49 to 1, not considering overhead, in a series of cutting tests by seven different operators. It behooves us, therefore, to conserve oxygen, but to the extent only that it does not penalize the operation.

In oxygen we are dealing with an invisible power, and while we can see the sparks fly when this power is released in a cutting operation there can be a considerable portion of the oxygen wasted either through ignorance or willfulness by the combination of large tips, high pressure and insufficient speed. Unless all the oxygen is brought into contact with the steel that is possible through the combined influence of stream size, pressure and speed, we are not using the oxygen cutting process efficiently.

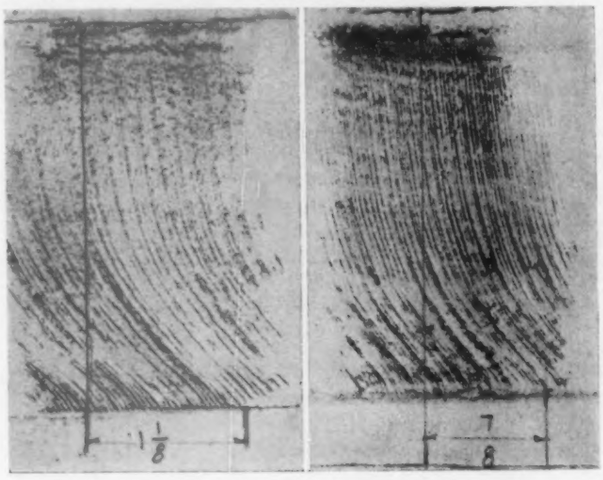


Fig. 1—Left: Cut by Operator No. 1 Showing 1⅛ in. Drag. Fig. 2—Right: Cut by Operator No. 2 Showing ⅞-in. Drag.

Anyone who has analyzed to his own satisfaction the phenomenon of oxygen cutting has determined that the most economical cutting is usually done where the drag lines are rather fine but regular at no point parallel to the axis of the jet, yet nearly perpendicular to the surface at the top but curving away rather abruptly in a direction opposite to the direction of travel after one-half of the thickness of the plate has been cut, leaving both top and bottom edges of the kerf clean and fairly sharp. As a rule, the greater the drag under these conditions the more efficiently has the oxygen been used. These conditions of drag line are applicable only for straight line work. For circular or irregular cutting the cutting lines must approach the vertical more closely to avoid under-cutting. If, however, the dimension tolerances are not too close, the same economical operation is possible.

It has become standard practice in computing cutting costs, in rating operators or in otherwise establishing values, to compare time, oxygen, fuel gas and labor cost in relation to square inches cut considering one cut surface only.

To illustrate the importance of these various factors viewed from different angles, a table is presented herewith giving the results obtained by seven different cutting operators working on the same grade and thickness of material. In this case the torches were *all operated mechanically*, and, therefore, the question of personal skill does not enter. This table will serve, therefore, to point out that *greater* differences may be expected

---

**Abstract of paper read before the Welding Conference, University of Minnesota, October, 1927, and also before the American Welding Society, Philadelphia Section.*

†Industrial Engineer, Air Reduction Sales Co., New York City.

in hand cutting under similar circumstances when differences such as shown can exist in mechanical operation when only the tip size, oxygen pressure and speed are under the operator's control and no exertion is necessary other than watchfulness on the part of the operator.

Operator No.	Thickness	Speed	Tip	Pressure	Sq. In. Cut per Cu. Ft.	Drag	Ratio Oxygen to Labor Cost
1	2¾	9.45	25-4	30	7.45	1⅛"	3.50
2	2¾	8.04	24-3	40	8.59	⅞"	2.55
3	2¾	8.	24-3	55	6.56	⅜"	3.36
4	2¾	7.93	24-3	70	5.82	⅜"	3.73
5	2¾	8.	25-4	30	7.02	⅝"	3.13
6	2¾	8.1	25-4	40	6.0	⅜"	3.80
7	2¾	8.74	25-4	50	5.52	¼"	4.38

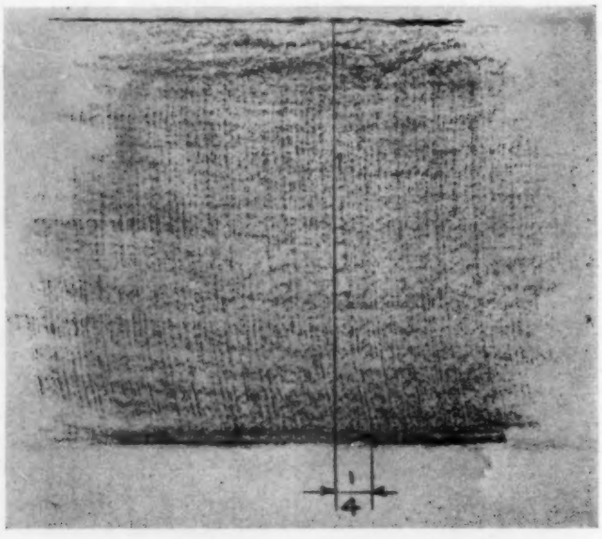


Fig. 3—Cut by Operator No. 7 Showing ¼-In. Drag.

Here we see the result of permitting operators to put into practice their individual ideas as to tip size, speed and oxygen pressures. Each operator worked on the same grade and thickness of material.

Operator No. 1 believed in a large tip and low oxygen pressure and just as much speed as would permit uninterrupted cutting. He secured by this reasoning very good economy, but his pressure was too low for the size of tip, and he consequently did not secure the maximum speed and fell a little short of the economical cutting mark established by operator No. 2.

Operator No. 2—In proof of what we have just said, let us look at the work of operator No. 2. We find that he chose a No. 3 tip, which is 39.4 per cent smaller in area than a No. 4 tip, but used oxygen at 10 lb. per sq. in. more pressure than the larger tip. Under these conditions he cut at 15 per cent less speed, but at 15 per cent more economy in oxygen. The fact that operator No. 2 cut 8.59 sq. in. per foot of oxygen and therefore did more economical cutting is further verified by the fact that in this instance his ratio of oxygen to labor cost was 2.55 to 1 as compared with operator No. 1 at 3.50 to 1. In other words, operator No. 2 selected a combination of tip size, oxygen pressure and speed that produced at an economical rate.

Operator No. 5 chose the same tip size and pressure as operator No. 1, but did not work up to the capacity of that combination in speed with the result that his operations were less profitable.

Now let us see what it means to go to the other extreme.

Operator No. 4—This man favored small tips and high pressure, and with a No. 3 tip, the same as No. 2 operator, he increased his oxygen pressure to 70 lb. and his speed decreased slightly. The result is extremely poor economy in comparison.

Operator No. 7, who believed in large tips, also believed in a considerably higher pressure than operator No. 1 and a slightly higher speed than the other operators except No. 1, but not in any sense the maximum speed for that tip size and pressure. The result is that his work is even less profitable than that of operator No. 4.

The reduction of work done to the basis of square inches cut per cubic foot of oxygen emphasizes the value of utilizing all the cutting power that exists in every foot of oxygen.

The table shows that the drag noticed in the case of Operator No. 1 was 1⅛ in., and ordinarily this would be considered as indicative of extremely economical cutting. We must, however, always take into consideration tip size and pressure in an analysis of this kind. The high speed, large tip size and low oxygen pressure would indicate that the pronounced drag was the result of dilution or contamination of the oxygen stream, to the point where cutting practically ceased. The drag in the case of operator No. 2 using a small tip was indicative of economical cutting, the lines being fine and regular, the top edge was sharp and the face perpendicular, denoting a narrow kerf with clear sharp cutting, affording only a slight opportunity for atmospheric dilution. It is interesting to note that this operator was by far the most valuable cutter from the standpoint of cost ratio.

In an analysis of cutting results we must bear in mind the fact that as the cutting lines more nearly approach the vertical, the cutting operation becomes more costly, for the reason that much unconsumed oxygen is passing out of the cut. This is very emphatically borne out by the figures shown in the table under consideration. The cost ratio figures speak for themselves and stand as a very convincing argument for intelligent supervision covering all details of cutting operations. Fortunately, wasteful operating conditions either do not exist or they do not long continue when the oxygen or apparatus manufacturers' cooperation in applying or supervising the process is in effect.

LINDE PUBLISHES BOOK ON WELDED PLUMBING AND HEATING SYSTEMS

A 26-page book entitled "Welded Piping" has been issued by The Linde Air Products Co. After sketching the history of progress made by the plumbing and heating industry in recent decades, and pointing out how the transition from mechanical to welded joints is just as surely a part of this progress as the transition from the old "wiped" joint to the threaded fitting, this well-prepared book proceeds to describe the applications of welding to various kinds of work and different kinds of pipe, outlining the procedure to be followed in making straight joints and standard and special fittings. The twenty-one illustrations show some typical welded piping installations, various types of fittings, methods of making fitting and bends on the job, and the equipment required for this work.

Besides stating the advantages of welding over other methods of joining pipe, the following are some of the subjects covered, "How to get welders for plumbing and steamfitting work," "Welded Piping in Residences," "Alterations in the System," Five Ways of Making an Elbow," and "One Contractor's Experience," the last being a description of the "cut and fit" method of installing a welded line.

CAUSTIC POTASH WITH A DISTINCTIVE NAME

A recent circular of Innis, Speiden & Company, New York City, importers and manufacturers of chemicals, calls attention to the fact that the caustic potash marketed by them under the trade name "Isco" for the use of air liquefaction oxygen plants is identified by this distinctive marking. The company has made a special study of the requirements of oxygen plants and furnishes caustic potash in special size packed in 100 pound drums, having determined that this size container is particularly adapted to the practical operating needs of such plants. Stocks are carried at warehouses located in industrial centers.

A Student's View of Welding

Scientific Attitude on Part of Supervisors Urged as Remedy for Unscientific Welding Practices

by Paul Ross

(Note: The author is a student of the Denver Public Opportunity School. It is not only a fine tribute to the quality of the instruction at that school, but also shows that the writer has learned to appreciate the responsibilities of the management in plants where welding is used. He has a real message for Welding Supervisors.—Editor.)

THERE is very little about the actions or work of the average welder to impress one with the scientific nature of the work. Yet everything that the welder uses and everything that he does is the result of laboratory experiment. In fact, all of the important sciences contribute to the principles of welding.

Many welders do not know the origin of their tools and materials. The technical side of welding is usually taken as a matter of fact, but too complicated for the workman to bother his head about. Prior to 1917 that was the general attitude of welding operators in this country.

During the first years of the World War and before our country was directly interested, our technical and military men watched the methods of all the combatants with a great deal of interest. It was quite apparent from these observations that welding made it possible for Germany to keep apparatus at the front more consistently than would have been otherwise possible. In many cases welding was performed only a few miles back of the front lines and the cutting torch was used to wreck any equipment which was abandoned in retreat.

When it became evident that we were to take an active part in the war it was thought advisable to amass as much information as possible on the subject of welding in order that the military forces might have advantage of the best advice. A committee was formed for this purpose but they soon discovered that there was no fixed rule or method for any particular job. Each welder seemed to have a procedure all his own and tried to surround himself with an air of mystery. The committee was forced to select the most promising theories and test them. Much time was consumed in doing this, so much in fact that welding was of less value to our military forces over seas than it should have been.

The Source of Heat

Acetylene and oxygen are the principal gases which can be used to advantage in welding. Both these gases were developed in the laboratory and remained there for several years, before they came into commercial use. These gases are manufactured now on a large scale in many plants, but even in the biggest and best plants the gases are carefully tested for purity at frequent intervals. The impurities are in fractions of one per cent and a constant effort is made to reduce them to an absolute minimum.

The blowpipe, commonly called a torch, was first devised by LaChatelier in 1895. No use was made of his discovery until 1900 when Fouche and Picard took it up and produced commercial blowpipes or torches in 1901. In 1903 M. Edmond Fouché sent an experimental torch to his friend, Mr. Bournonville. In 1906 the Davis Bournonville Co. was organized and early in the following year they secured the patent rights to the Ganther Ely blowpipes and began selling them in this country.

From then to the present time chemists and physicists have been constantly at work to produce a torch which is efficient, safe in operation, and capable of maintaining a neutral flame under all conditions of service. A few torches approach quite closely these requirements.

We Still Need the Laboratory

If the welder were provided with a perfect blowpipe and chemically pure gases, he would still need the help of a laboratory.

In the first years of the industry the only filling material available was iron made in the regular manner and it was thought that thin strips, of the same material as the pieces to be joined, were the proper filling material to use. Failures and repeated testing proved that this is not the case on all classes of material. The chemist and metallurgist had to solve the problem and at the present time many large companies make nothing but filling material.

Although there is now available filling material suitable for nearly every class of work, still every steel plant which makes this material maintains a chemical laboratory and a chemist to safeguard the quality of their product. Most of these manufacturers also maintain a research laboratory for the development of new materials as they are needed.

Thank Chemists for Fluxes

Fluxes play quite an important part in welding and, for these, we must thank the chemist. Without chemistry there would be no fluxes. There are so many uses for a flux and so many fluxes to meet these requirements that unless the welder knows something of the nature and action of each particular flux, he is apt to make a dozen trials before the proper one is found. Especially is this true in repair work or in the job-shop where any job is scarcely ever like any other one. Quite often a proper flux is not at hand. In such a case the welder must rely on his knowledge of chemistry to help him out of his difficulty. On badly burned cast iron such as furnace parts, grates and so forth, sodium chloride (common salt) is of much value if mixed with the ordinary cast iron flux. On certain alloys borax or ammonium cloride (sal ammoniac) are each quite useful.

The welder being provided with a supply of tools and material must use chemistry, physics, metallurgy and metallography to accomplish his work. The fact that he applies these sciences to his work without knowing it, does not lessen their importance. It is quite possible to weld most materials so that a fracture will result from stress in the piece itself and without any outside force being applied. (Welding a sewing machine treadle is an extreme example of this.) By a proper application of metallurgy, a weld in the same piece of iron may be made either hard or soft, and an examination by a metallographist will reveal which condition obtains and why such a weld resulted.

Inspecting Welds

Thorough inspection of welds would require a chemical analysis, macroscopic and microscopic examinations together with tensile, impact, shear, vibration and hardness tests in a physical laboratory. In everyday practice these tests are too costly and too slow for general application. However the inspector who passes on welded articles by merely looking at the weld is basing his judgment on the visible evidences of chemical actions that have taken place. The kind and amount of slag on or near the weld, the color and thickness of the oxide scale and even the play of colors along the

edge of the heated zone are all very important factors in an inspection of production welding.

It is quite apparent that consistently good welding must be the result of thorough consideration and careful planning. The entire subject is usually referred to as "Procedure Control", and should include the following:

Selection of a welding process
Proper design for the purpose selected
Selection of apparatus
Selection and inspection of materials
Selection and training of operators
Proper welding technique
Competent supervision of welding operations
Testing of finished product.

Especially in production work is the selection of a welding process important. Costs are often the deciding factor in the securing of contracts and the plant manager who chooses the least expensive method of obtaining a given result is apt to enjoy the largest volume of business.

This paper is devoted to the oxy-acetylene process usually called gas welding, yet it is recognized that quite a few welding processes are used in addition to this one.

Each Process Requires Special Design

After a process of welding has been decided upon, the next step toward good welding is the proper design and preparation of the joints to be welded by the means selected. It is just as futile to substitute one process of welding for another as it is to substitute welding for riveting. Each requires a design all its own.

The selection of welding equipment is probably of more importance than is usually supposed. In gas welding, good regulators and hose are essential, whatever type of blowpipe is used. The great variety and number of blowpipes available makes the choosing of one a subject of considerable latitude and offers opportunity for the purchaser to exercise his personal opinions to a great extent. If a variety of work is to be welded in the same shop, then the selection of a certain size for each job becomes necessary. This may be accomplished by changing tip sizes on the same blowpipe, or by providing a variety of sizes of blowpipes. As a general rule, the lightest blowpipe which can be used to advantage, is to be preferred. The handling of unnecessary weight only tends to exhaust the welder and lessen his (or her) efficiency.

The welders should be encouraged to wear proper clothing for their work. Goggles constitute the most important piece of personal equipment. The mere fact that goggles are made of dark colored glass, does not necessarily mean that they are suitable for welding, nor is the color or density any indication of its powers of protection. The glass used in welding goggles should be especially made for that purpose and should carry the guarantee of a reputable manufacturer. To be efficient, the glass must absorb a high percentage of the rays between .1 micron and .4 micron and between .8 micron and 5 microns.

In a paper before the Institute of Welding Engineers (England) Mr. Buttler said:—"If the goggles supplied to the welder are not capable of absorbing harmful radiations, the operator will invariably suffer, and as a logical conclusion the work itself will be inferior in quality. An employer who supplies, for eye protection purposes, goggles whose chief merit (in his opinion) is their cheapness, is actually courting that inferior quality of welded work which must result from indistinct vision."

Good Materials Necessary for Good Work

The selection of welding material would include filler material, fluxes, gases, etc. Unless these are bought from manufacturers whose reputation renders their product above suspicion, tests should be carried out on enough samples to satisfy the supervisor or engineer that he is getting what he specified. In case acetylene is generated on the premises, daily tests should be made for purity. This testing is inexpensive and may mean the difference between good and poor welding.

The choosing and testing of welding operators is of prime importance. They should be chosen for honesty and intelligence as these are absolutely essential qualifications. If the test reveals a lack of manipulative ability a short period of training under a competent instructor will usually bring the applicant up to standard on any one kind of work.

Responsibility of Executives

The proper materials, apparatus, and operators being assembled, the next most important item is supervision. This includes foremen, supervisors and inspectors. In the smaller works these may be combined in one man but in the larger plants, will require three men or more. The supervisor will make sure that a proper sequence of operations, is carried out, that the correct size of blowpipe and filler rod is used and that the welds are properly cared for, if any after treatment is indicated.

The inspector holds a position of the utmost importance where any appreciable quantity of welding is done. He it is, who must maintain the standard of quality in the finished product. He should be able to make thorough tests as often as he deems necessary and should apply rough tests along with visual inspection at frequent enough intervals to satisfy himself that the proper quality of weld is being produced.

The art of fusion welding as applied to the harder metals is comparatively new, but the fundamental sciences on which it is based were already far advanced at the time of its inception. The welder has always been able to find a solution for his problems if sufficiently versed in chemistry, metallurgy, metallography, physics and the principles of structural engineering. This and the urgent need for welding have made possible a progress in twenty years that would have required a hundred years two centuries ago. Today the young industry has in its ranks qualified designers and capable workmen, and any one who is willing to use the best men and materials available can secure consistently good results from welding.

One is continually hearing the statements that "welding is no good," "Welds will not hold" and similar assertions. Without exception, these reports come from a plant or factory where an engineer, a foreman or a mechanic who is proficient in another line, has been intrusted with the responsibility for welding and the man has failed, because he knew nothing of the subject he was asked to handle.

Some Welding Superstitions

Before writing this paper the author has visited a great many shops where welding is done and has talked to the welders who do the work. Many of these operators claim to have had ten or twelve years experience. Many of them more. One such operator said in answer to a question, that he liked the ——torch because it made a soft flame and was better for cast iron or light steel, but he wanted a——torch when he welded the heavier pieces of steel. He explained the latter torch had a cutting flame and that he could cut down the sides of the V faster, and to better advantage, than with any other torch. He refused to believe that the "cutting flame" was an oxidizing flame carrying twenty to thirty per cent excess oxygen and therefore unfit for welding. He also refused to believe that the oxidation of one gram of iron produces as much heat as the burning of one foot of acetylene.

Another welding operator, rather boastfully, said that he did not have to wear goggles. His eyes, he said, were good enough to see without goggles and, any way, they were not any good. He seemed quite amused at the story of invisible radiations and their effect on the eye. This same man also said, "You can't learn nothing from them books an'

schools. You have to learn by welding just like I did."

In the years since the war was ended, interest in the more scientific side of welding has grown by leaps and bounds. The better class technical schools have become interested in the subject, and quite a few of them have included in their curriculum courses applicable to welding. For lack of qualified instructors or other reasons, none of these schools have complete courses on welding. The Denver Public Opportunity School is one of the few in the United States which offers thorough instruction in welding, both practical and scientific.

The past year has heard much discussion of the relative merit of welding in the manufacture of tanks, boilers and similar articles, and in the installation of pipe lines and piping systems and in the erection of structural steel buildings. The older engineers have been opposed to welding in many cases, because they were unfamiliar with the subject and had no ready reference on the various details required. This condition is being overcome by the combined efforts of the American Welding Society, The American Institute of Structural Engineers, and some large manufacturers, who are directly interested. At this time, the two engineering societies referred to are collecting data and compiling information on the subject of welding as applied to certain specific problems, and this is being disseminated to the members as rapidly as it is prepared. When this research is completed and the results published in the form of an engineer's hand book, much progress will have been made for welding. As planned now, this hand book will be a practical application of the scientific principles of welding and will contain formulas for the calculation required in design for welding.

The outlook for welding now is, that in the near future every operator or his immediate superior will be required to have more knowledge than can be acquired by an ordinary apprenticeship.

WELDING A 2200-FOOT VERTICAL PIPE LINE

The installing of a 10-inch pipe line from the surface to the 27th level of a mine presented some unusual problems, particularly since the clearance in the shaft was very small, which would have made it very difficult to use any method but welding in joining the lengths. With a 2200-ft. head of water the pressure at the bottom of the shaft was nearly 1000 lb. per sq. in., which provided another reason for welding.

There were certain factors, however, which made it impossible to weld every joint. Since it would have been difficult to support very long sections in this crowded pipeway (already containing several cables and 3-in., 6-in., and 12-in. pipe) and as the dropping of a section might cause damage amounting to $100,000, it was decided to weld the line in 100 ft. sections, with flanges on each end of the section.

Oxy-Acetylene Tips describes how this job was carried out. Four 20-ft. lengths were welded into two 40-ft. sections above ground, and the flanges welded onto every fifth section before lowering into the shaft, where the rest of the welding was done by experienced underground crews. The wall thickness of the hydraulic piping varied from ¾ in. at the foot of the line to ⅜ in. at the top.

In making the welds above ground the pipe was blocked so that there was about ⅛-in. opening at the top of the joint and 1/16-in. at the bottom. A tack weld was made on each top eighth and one at the bottom as quickly as possible. Welding was started near one of the top tack welds and proceeded on around and toward the narrow opening. This method took care of expansion and contraction in such a way that a perfectly square joint was produced. Particular stress was laid on the necessity for perfect alignment, as the line had to be absolutely straight. To straighten the length after it had been lowered into the shaft would have required two hours or longer. It was found, however, that the procedure described obviated the necessity for any straightening underground.

WELDED PIPING A FEATURE AT MID-WESTERN POWER SHOW

Although a number of welded products were exhibited at the Mid-Western Engineering and Power Exposition which was held in the Coliseum, Chicago, February 14th to 18th, of particular interest were the exhibits pertaining to the welding of power piping systems. At the booth of the Pipe Bending Process Company were displayed bends ideally suited to welding, of uniform wall thickness, and in all sizes up to 20 inches in diameter. Bends made from steel, brass, bronze and aluminum pipe were shown, and a number of bends were welded to each other or to straight lengths to show the great variety of fittings that can be made by using these bends in various combinations.

Another interesting exhibit was that of the Linde Air Products Co., where a completely welded steam header was displayed, into which were welded different types of nozzles, reducers,

Steam Header For Power Plant, With All Nozzles, Flanges, Reducers and Trap Welded.

flanges, bosses, etc. One feature worth especial notice was the saddle designed for the joint between header and nozzle. A joint at such a point on a high pressure line is subjected to greater strains than either the header or the nozzle, and accordingly the saddle is made somewhat thicker than the pipe walls to provide the necessary reinforcement. This type of joint also substitutes straight butt welds for the one right-angle weld, thus still further strengthening the joint. In other parts of this header also different wall thicknesses were used to provide a uniform safety factor. This header was fabricated by the Pittsburgh Pipe and Equipment Co., under Linde procedure control. The illustration shows the header with a section cut away so as to clearly show the quality of the welds and more particularly the excellent engineering design where both the limitations and advantages of welding were taken into account.

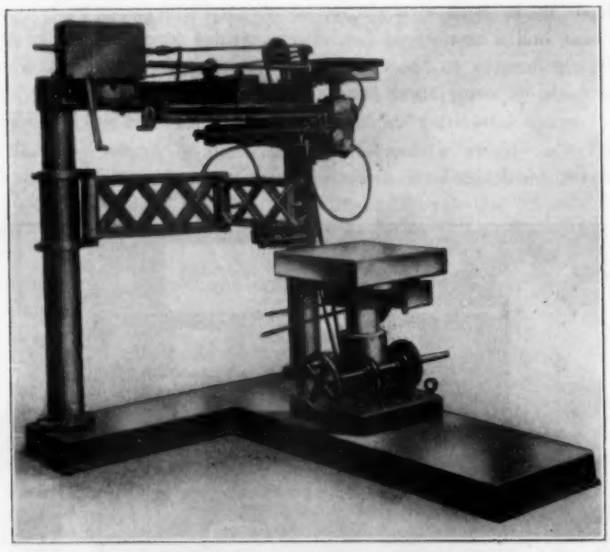
The Grinnell Co., Inc., Providence, R. I., also exhibited some examples of welded piping, including the test samples described in the February issue of *The Welding Engineer*.

A number of the other exhibits contained examples of welded tank, machine, or other construction, all of which provided conclusive evidence of the growing use of welding in a variety of industries.

GODFREY OXYGEN JET CUTTING MACHINE

At the National Railway Appliances Exposition held recently in Chicago, one of the exhibits of interest to users of welding was that of the Godfrey Oxygen Jet Cutting Machine, which has been introduced into this country and Canada by The Hubar-Jones Corporation, 13 Astor Place, New York City.

By means of finely adjusted speed control, rigidity of cutting torch, and flexibility of motion, this machine will cut iron or steel plate accurately to whatever shape required. It can be operated manually as on a milling or slotting machine, enabling much work to be done without the use of a template. The jointed arms have a range of 7'x2', 6'x3', 5'x3½'. The machine is equipped with a rotary motion which enables circular holes or blanks, from 1½" to 36" diameter to be cut without templates. It is also equipped with a rotating table, by means of which it



Godfrey Oxygen Jet Cutting Machine.

is possible to cut discs and holes up to 15 feet or more in diameter. This table will carry eight tons, and is under exactly the same fine speed control as the torch. It can be rotated at speeds from one revolution per minute to one revolution in an hour and forty minutes. Below the table is a division plate which enables the operator to cut circular holes or do slotting without having to reset the work. The table, under full load, is operated by a ¼ h. p. motor, which also operates the other mechanical features of the machine.

For repetition production of various polygonal shapes, and for simple irregular shapes, a template can be used, and for complicated shapes the machine is equipped with a specially designed automatic attachment.

The high pressure Godfrey cutting torch has been designed to avoid any hardening of the metal at the cutting face, thereby obviating the necessity for subsequent annealing of the work. So accurately will the machine cut to a finished size, with thicknesses up to 12", and even at a 45° level, that further working of the cutting face is unnecessary. Should, however, a special friction surface be required, only 0.002 in. to 0.005 in. need be ground off. The speed of cutting varies from 18 inches a minute for ¼-in. plate to 3 inches a minute for 12-in. stock.

NATIONAL SAFETY COUNCIL ANNOUNCES PHOTOGRAPHIC COMPETITION

In connection with its crusade against all preventable accidents, the National Safety Council is offering $200.00 in cash prizes for the best photographic prints submitted which illustrate a possible source of danger, or show how to prevent accidents, on the streets, in homes, work shops, or factories. The pictures may also feature the benefits of safety, such as possession of limbs and property, a steady income, a comfortable old age. Or they should caution to be careful because of definite undesirable results of accidents. The idea is the big thing in every picture. The picture itself should tell the story, without any lettering whatever.

Welding operators and others who come into daily contact with chances for an accident should be able to find good subjects for a picture which could be used to warn others against mistakes or carelessness. There are twenty-five prizes offered, ranging from $3.00 to $50.00. The complete rules and conditions of the contest can be obtained by writing "Photo Contest Secretary," National Safety Council, 108 E. Ohio St., Chicago, Ill. The contest closes July 16, 1928.

PROFESSOR THOMSON TO ATTEND WORLD CONGRESS OF ENGINEERS AT TOKIO

Professor Elihu Thomson, director of the Thomson research laboratory of the General Electric Company, has been named a member of the American committee of the World Congress of Engineers to be held in Tokio, Japan, in November, 1929. The appointment was made by Secretary of Commerce Herbert Hoover.

This is the first congress of its kind ever held and according to Baron K. Furuichi, president of the Engineering Society of Japan, is for the purpose of promoting international cooperation in the study of engineering science and problems in all its branches and stimulating a sense of brotherhood among the engineers of the world.

Among the other well known members of the American Committee appointed by Secretary Hoover are Thomas A. Edison, John Hays Hammond, Charles M. Schwab and Orville Wright.

WELDING EXHIBITS AT RAILWAY APPLIANCES SHOW

The annual exposition of The National Railway Appliances Association was held at the coliseum, Chicago, March 5 to 8 inclusive. As usual there were quite a number of exhibits of welding equipment and supplies and welded products. Among the exhibits of interest to the welding industry were those of the following manufacturers: Air Reduction Sales Company, New York City; American Steel and Wire Co., Chicago, Ill.; Electric Rail Weld Service Corporation, Chicago, Ill.; General Electric Co., Schenectady, N. Y.; Hubar-Jones Corpn., New York City; E. A. Lundy Co., Pittsburgh, Pa.; Metal & Thermit Corpn., New York City.; Metalweld Incorporated, Philadelphia, Pa.; Ohio Brass Co., Mansfield, Ohio; Okonite-Callender Cable Co., Passaic, N. J.; Oxweld Railway Service Co., Chicago, Ill.; Page & Steel Wire Co., Bridgeport, Conn.; The Rail Joint Co., Chicago, Ill.; Torchweld Equipment Co., Chicago, Ill.; Westinghouse Elec. & Mfg. Co., Pittsburgh, Pa.; Wilson Welder & Metals Co., Hoboken, N. J.

NATIONAL CARBON CO. MOVES NEW YORK BRANCH TO NEW QUARTERS

On March 15th, 1928, the Branch Sales Office and Factory of the Carbon Sales Division of National Carbon Co., Inc., moved from its former location at 357 West 36th St., New York City to new and much larger quarters at the company's plant at Fourteenth and Henderson Sts., Jersey City, N. J. The company states that this change more than doubles the size of the former plant and that considerable additional manufacturing equipment has been added to meet the increasing demand for its brushes and carbon products in the Eastern District territory.

WELDING REDUCES MAINTENANCE COSTS ON STREET RAILWAY TRACK

The Eastern Massachusetts Street Railway, serving the Boston district over nearly a thousand miles of track, tells in *Engineering and Contracting* of the improved service and reduced upkeep cost which have resulted from years of experiment with various methods of repairing worn track by welding. This company has developed a standard welding procedure which can be carried out under congested traffic conditions and with small gangs. In six years 115,000 joints have been welded with the arc, and so far as known not a joint has failed by impact of wheels of the cars. In fact, there have been very few failures from any cause. Besides effecting savings in maintaining the tracks, the noise of the cars has been reduced to a minimum, and derailments have shown a steady decrease each year, this latter result being attributable in part to the work of welding and grinding and in part to other maintenance work on track and roadbed.

Frank B. Walker, chief engineer, summarizes as follows the important factors contributing to the success of the arc-welded rail joints:

Complete repair of joints prior to welding.

Adoption of properly designed joint plates.

Proper welding methods.

Use of suitable welding and grinding machines.

Constant supervision.

Intensive training of welders.

Application of visual and breakdown tests upon completion of work.

In addition to the adoption of heavy fish plates, it was found that much of the old, lighter rail could be welded by use of the original angle bars, with the outstanding flange cut off by the acetylene torch, and although this kind of joint was known to be of considerable less strength than the rail, out of the thousands of old plates that were used, only a small number have failed. This led to the conclusion that the actual strength of the welded joint was not of as much consequence as the kind and quality of welding.

Exterior and interior rail joints of all special work are also being welded, as it is believed that by the elimination of such bolted joints the life of special work will be materially lengthened and the noise of pounding joints eliminated. With two exceptions, there has been no trouble due to breakage on the thousands of pieces of special work which have been welded.

The pounding of cars over rail joints and corrugated rail has been still further reduced by surface welding and then grinding.

COMPLETE SHUTDOWN OF PLANT AVOIDED BY BRONZE-WELDING

In testing a large condensation pump preparatory to starting up a sugar refinery for the season's operations, the water end of the pump went to pieces. Without this pump it would be impossible to open the plant on time. Dismantling revealed fractures extending the entire length of the cylinder, through the valve chamber, and around the intake chamber, with two fractures in the front cylinder head flange.

The method of repairing this pump is described in "Oxy-Acetylene Tips". Before welding, a temporary preheating furnace was built around the casting, which was heated enough to relieve any strains that might have been caused by the freezing. All welding had to be done from one end as the back has only one opening 2½ in. in diameter. The small bore (8-in.) and the long stroke (18-in.) also increased the difficulty of welding the fracture extending the entire length of the cylinder. In spite of it, all five fractures were welded in three hours, using 18 lb. of bronze welding rod.

Repairs of this nature are quite common on pumps, grinders, and other heavy machinery in a sugar mill, effecting savings of tens of thousands of dollars annually in replacement and shutdown costs.

GAS AND ARC WELDING USED ON LARGE TURBINE MANIFOLD

In installing a 56-in. penstock for the Roosevelt Water Conservation District, near Phoenix, Arizona, a manifold was required to connect the penstock with the three turbines at the station. The manifold, and its two branches with the flanges for connection to the gate valves, were electric welded in the shop,

Manifold Connecting Penstock With Three Turbines.

the branches being later welded to the manifold in the field, using oxy-acetylene.

The manifold was 19 feet 8 inches long, 56 inches in diameter at one end and tapering down to 36 inches at the other end. It is fabricated of ¼-inch tank steel, and the flanges are of 4 inch by 4 inch by ½ inch angle iron. The branches, one 24 inches in diameter and the other 20 inches, are set at angles of 30 deg. and 45 deg., respectively, to the manifold to reduce to a minimum the friction of flow of the water, which enters at high velocity under a 59-ft. head.

PROPER ALIGNMENT IN CAST IRON WELDING

In aligning the broken parts of a casting, preparatory to welding them, it is preferable to do so without chamfering them beforehand. It is better to melt out the metal with the blowpipe to form the groove, proceeding immediately after, if possible, to add the metal from the rod to weld it up again.

By this means not only is better alignment obtained but much laborious work, incidental to chipping out with hammer and chisel, is avoided. Furthermore, the heat engendered by the melting out process aids materially in making the weld.

This method was found advantageous in welding a heavy punch press. Owing to the thickness of the casting where it was broken (measuring 24 inches across by 6 inches on each side) it was, however, necessary to preheat it, so it was laid on its side, and a charcoal fire built around; it was then welded on the one side and allowed to cool. The next day it was turned over and again preheated to a dull red when the other side was welded in similar manner. So that there should be no fear of it breaking again all the welds were reinforced one inch thicker than the original casting. This press has now been in constant use for 2 years since it was repaired.

The Welding Review.

RED SHORTNESS OF WELD METAL

(Discussion of a paper on this subject read by A. H. Goodger before the Institute of Welding Engineers, London, and published in the February 1928 issue of the Welding Engineer.)

DISCUSSION

The Chairman, commenting upon the wealth of material which the paper contained, said that there was scope for discussion by the actual welder and by those interested mainly in the metallurgical or technical side of the problem.

With regard to fluxes he thought there were members present who would disagree, as he did, with Mr. Goodger's suggestion that most of the fluxes used for coating electrodes were experimental in their nature. He would like to ask him, how many of the compositions he had thrown on the screen were patented and why he had chosen No. 4 entirely for his experimental work.

The figures quoted and obtained by Wanamaker referring to nickel coated electrodes, raises the question as to whether the good results obtained were really due to the particular flux, or to the nickel coating. He would like to know if Mr. Goodger had made experiments on these lines as he considered that equally good results might be obtained with nickel coated electrodes and an ordinary flux.

Mr. J. H. Parker said that the specimen marked No. 1, which was welded by the oxy-acetylene process, appeared to be practically perfect. The electrically-welded specimens, however, were not so good, but flux-covered electrodes were used in those cases, and he asked whether a flux was used in connection with the oxy-acetylene weld. In his view, the test was not a good one, because when welding metal one wanted to get a metal of the same description to weld with. He assumed that in the welding of the oxy-acetylene-welded specimen a mild steel wire was used, and that there was a low percentage of carbon in it, as in the case of the electrode used for the electrically welded specimens. Although the photographs showed breakages, he could mention instances in which good welding had been done with electrodes on the arc welding principle, and in which $\frac{5}{8}$ in. plates had been pressed out without breakage. He was of opinion that the electrodes had not been properly manipulated in the welding of the specimens dealt with in the paper.

Mr. F. E. Saunders asked whether the welds dealt with by Mr. Goodger were produced with alternating or continuous current. The idea of the flux, he supposed, was to facilitate the melting of the steel, to keep out air and to prevent oxidation.

Mr. E. W. Birch said that on the first reading one was given the impression that the problem of the needles in the structure of the metal was to a certain extent cleared up, and that they did not consist of nitride, but of oxide. After carefully digesting the information available, however, he was not quite so sure that we should make that deduction too hastily. With regard to the analyses of the wires and welds, he said that Mr. Goodger had drawn particular attention to the carbon content, and had made no reference to the sulphur, phosphorus and manganese. One knew from experience that the hot-shortness of steel was often brought about by the presence of sulphur. If one considered the wire and the subsequent weld, in a case where a lot of the carbon had been lost, the percentage of sulphur, assuming the amount remained somewhat like the figure given, would be much greater in the subsequent weld than it was in the original condition, and it was possible that the presence of the sulphur might have something to do with the red-shortness. Also, if one had not sufficient manganese in excess of sulphur, that fact would also tend to cause red-shortness. Therefore, the question of the sulphur and manganese content must be taken into consideration, and that was especially important when trying to differentiate between the acid and basic plate. A good deal of work has been done, and had recently been published, on the question of the occlusion of gases and the effect upon metals. One interesting point which had been brought out was that the occlusion of the gases was dependent to a certain extent on the shape and surface of the sample, and that was a point which might have some influence on the question of the absorption of gases. Another important point connected with the problem of what was termed "red shortness"—which he believed was merely an inter-crystalline brittleness—was that fusion took place more readily in the grain boundaries than through the crystals, and there was also the possibility of reaction between occluded gases and any segregate between the grain boundaries. The bend tests and micro-photographs showed that fracture tended to take place through the crystal boundaries and not through the grains, and that might be due to the occlusion of a gas. It had been proved also that gases in solution nearly always had an embrittling action on the metals, and in most ductile metals the fracture occurred through the crystalline grains rather than along the boundaries. He asked Mr. Goodger whether he had taken photographs of the fractures in brittle welds, in order to find out whether fracture took place through the grains or around the boundaries. Reverting to Mr. Goodger's conclusions as to the needle-like inclusions, he said he did not think we could dismiss quote so readily the work of other investigators. The photographs shown tended to prove that it was not nitride, but he did not think we could say that it must be oxide. He asked whether Mr. Goodger had tested the metal from the Delhi Column, in order to find out whether that which contained the needles, and which were said to consist of oxide, was red-short. Presumably that material should be brittle.

Mr. P. L. Roberts said it was interesting to find that Mr. Goodger had used an electrode which was characteristic of mild steel, and yet had apparently succeeded where everybody else had failed, and had obtained welds which were forgeable, although he did admit that a lot of them were red-short. Probably success was due to some factor not included in the available data. It was unfortunate that often apparently valuable data obtained from abroad was not complete, and there were one or two important points missing, as a result of which the data was practically useless. In one case mentioned in the paper the carbon content of the welding wire was given as 0.5, and the weld had a carbon content of just over 0.2. He asked whether Mr. Goodger had found any hardness in that weld, because he had considerable difficulty in welding steel castings with a very low carbon electrode, due to hardening at the point of fusion—castings varying from 0.3 to 0.4 per cent carbon only. He agreed with Mr. Goodger's remarks with regard to fluxes being experimental. Mr. Goodger might have enlarged on that. Apparently what he meant was that it was no good just saying that certain elements or certain compounds were strongly de-oxidising, and that we would make up a flux of these elements or compounds and stick them on the electrode. His point was that there were many considerations besides the chemical considerations which must be taken account of. First of all, the operator had to be considered. The flux had to be used satisfactorily, i. e., it had to be of a lower melting point than the steel, it had to flow smoothly, and it had to make the deposited metal fluid and easily manipulated—and there the importance of the human element, as mentioned by the chairman, would be appreciated. The human element was the first consideration. When one had settled that, one could deal with the other factors, such as the chemical analyses of the fluxes, and so on, in order to get them as nearly correct as possible to give the deposit required. He had taken analyses of a considerable number of electrodes, and the results bore out almost precisely the figures which Mr. Goodger had given. They all seemed to be ferro-silicates, or ferric oxide of that variety, because under the arc they were very fluid and easily manipulated, showing that fluxes of that sort were mechanical rather than chemical in their operation, and protected the steel by forming a film over the surface, rather than by protecting it chemically. In one of Mr. Goodger's micro-photographs, showing a weld on boiler plates—it was not in the paper—in connection with which he had used a high carbon electrode, one could distinctly see the elongated crystals of ferrite, and the structure of the weld corresponded very closely with that of the other metal. If he could produce that with a high-carbon steel electrode his results were very good; so far as one could see from the photograph, it was almost ideal.

Mr. Goodger, replying to the discussion, said that he did not wish to suggest that carbon was the only deoxidizer, and that the needles in the structures of welds were definitely proved to be oxide of iron, but he would point out that when one carried out a scientific investigation one wanted to make out one's case as strongly as possible. It was for somebody else, who was investigating on other lines, to criticize it. He admitted that the case in favor of the needles in the structures of welds being oxide was not completely made out, but the evidence put forward made a strong case.

Discussing the reference to his statement that fluxes were experimental, he said he adhered to it. One might say that one would make an ideal flux, but it had to be tried out from the point of view of the conditions under which the individual welder was using it. It must conform to quite a number of physical as well as chemical requirements. With regard to nickel coatings on electrodes, there were volumes of patent specifications, some of which did not mean anything, but some did mean quite a lot. In his reference to nickel electrodes, he was not limiting them to those coated or plated on the outside, but included those with nickel incorporated in them. For instance, one might take a wire containing $3\frac{1}{2}$ per cent nickel steel and utilize that. He agreed that the good results obtained by Messrs. Wanamaker were due primarily to the nickel, and not necessarily to the flux.

Replying to Mr. Parker, he said that the acetylene weld referred to was made without a flux, and, as far as he could tell, the manipulation of the electrodes in connection with the welds was satisfactorily done. The welds were made by a welder working for a big firm in the north of England, who was making a very large number of commercial welds which were tested thoroughly by means of all methods of inspection. Also, the figures were verified on practically every type of covered electrode on the market. He had purposely refrained from giving the names of any electrodes, because obviously it would not be fair to say that a particular weld was done with a particular electrode.

The contribution of Mr. Birch had been very much to the point, and he (Mr. Goodger) could give figures covering the complete analyses, which had been omitted from the present paper merely in the interests of brevity. The sulphur and phosphorus contents were very low indeed, both in the original wires selected and in the metal. The results simply showed what had been obtained with the element carbon. Of course, one could investigate similarly the results obtained from every other element in the electrodes used, but that would involve a tremendous amount of work, which he had not yet had time to carry out. A good deal of work had to be done, and he had not yet finished it. Mr. Birch would agree that one could alter only one detail at a time in an investigation of this character. The effect of occluded and dissolved gases was vital, and there was need for investigation. What he was attempting to do was to throw doubt on the statement that those needles in welds were definitely nitride. One of the members of the Institution had stated definitely on many occasions that the inclusions were nitride, but he (Mr. Goodger) held that that was not proved. The work he had put forward indicated that there was a great deal more to be done before any of these problems were settled. The piece of the Delhi Column was so tiny that it was almost a work of art to make a polished surface on it, but he would endeavor to obtain another piece and test it for red-shortness.

The point raised by Mr. Roberts with regard to forging was rather difficult. One could hot work a specimen in two or three different ways. In the specimens he had shown, the load had been a sort of tensile load all the time, so that if there were lack of adhesion between the grains, one would expect the fact to show up instantly. Eschholz's results were obtained by rolling or hammering, a method which gave more the conditions of a crushing test piece. The two were not altogether comparable. Eschholz had pointed out that a very large number of welds which he had obtained, and which were forged by hammering or rolling, were not brittle. Whether they would stand up to the hot bend test it was impossible to say. With regard to the hardness of the welds, he said that those in the paper were done on mild steel plates, and in no case was the weld unduly hard. He had come across the condition of hardness in a weld on cast steel, as mentioned by Mr. Roberts. It was surely not the added material which was hard, however, but the effect of heat treatment on the cast steel, or high-carbon steel containing, say, 0.3 per cent of carbon, at a short distance from the weld. It was not the point at which fusion had taken place.

Mr. Roberts said he knew that the hardness took place in the casting, but his point was that if there were hardness due to rapid chilling under arc conditions with 0.3 per cent carbon, would not one expect it, to an appreciable extent at any rate, with 0.2 per cent carbon

Mr. Goodger replied that the conditions in the weld metal were different from those in the material one was welding. The cooling range was different, and it was most probable that the rate of cooling through a given temperature range was very different.

There was no doubt that on depositing 0.3 per cent carbon steel in a weld on a 0.3 per cent carbon steel casting, the zone of the casting near the weld would be harder than the actual weld metal. It was the steel which had been heat treated at a temperature well below the melting point that was the hardest. Of course, a 0.3 per cent carbon steel, if quenched in water, would harden; the hardness of a 0.3 per cent carbon steel would increase from a hardness of 140 Brinell to 300 Brinell.

The welds were made as stated by a competent welder working on a multiple-operator, direct current, motor driven set. The voltage and current were regulated by resistances and the whole plant gave very constant and satisfactory results. The open circuit voltage was 60 volts and the voltage drop across the arc approximately 23 volts. Especial care was taken to maintain a short arc.

MANUFACTURER FINDS THAT LOCAL CONDITIONS FAVOR EMPLOYMENT OF WOMEN AS WELDERS

Women welders, as a solution to the labor turnover problem, has been proven by the Boyle Manufacturing Company of Los Angeles after over ten years of experience with both men and women. It was found by this concern that after it had spent several months and some money in training welders, they were prone to leave and accept work with the various oil companies which, because of the difficulty and distance of pipe line constructions, paid a high schedule of wages for welders; consequently the Los Angeles company was merely acting as a training school for the oil corporations.

Women had been employed for some time in other parts of the shop and it was decided to try them as welders, believing that they were less liable to move on at the offer of higher wages from the other concerns. The experiment proved a success and now the Boyle concern has some twenty-eight women so employed.

The majority of these women are married, for the manufacturing organization has also discovered that the married employee is a more stable worker than the unmarried, for the home ties are stronger and the mobility is less. Where a married woman is employed, usually her husband is also working in the same neighborhood or at least in the same city. It is seldom that they both are out of work at the same time and one tends to hold the other in the same locality.

The efficiency of these workers has been found to be about the same as the men with perhaps a slight edge in favor of the women in the more delicate and intricate operations. The main argument in their favor has been the stabilized labor supply and the saving to the company has been great by their use.

From the standpoint of the women, it is a fine occupation for the work is all piece work, with the exception of some of the heavier operations, and the net return to them is greater than most any other type of work would produce. In some cases it has been found that certain of the workers were making as high as $1.25 per hour in the welding work which compares more than favorably with the $21.00 per week returned by other trades to women employees.

There are periods of a day or two when the plant is shut down and with men employees this would work a hardship. In the case of the women, however, the most of them are not dependent upon the wage for support and it also gives them an opportunity to do work about the home that they might not otherwise have time to accomplish. Particularly is this true in the case of the married women for they have husbands that are contributing to the family upkeep and they also have homes to take care of.

Two plants are operated by the Boyle organization, one at Alameda, Cal., and the other at Los Angeles. In the Alameda plant there are eighteen of the feminine welders, all Portuguese girls who came to California from Hawaii and who keep the plant well supplied with labor for there is quite an extensive colony of these people in that section of the country. Being rather clannish, they make every attempt to maintain the people of their own race in the positions.

The Los Angeles girls are American with the exception of one or two who are Spanish,. In the southern plant there are ten of the women welders employed at all times.

Most of the work which these women do is in the barrel department or with the lighter material. Some have been used on the ⅜ and ¼-inch metal, but in this it was necessary to have men put the articles in place and do the moving. The greater share of the blue print production has been done by the men except in the lighter material products.

Another advantage in favor of the women employees has been the fact that on the average they are quicker to learn the art of welding and the training period has been cut down.

So far these workers have not been used in arc welding, but W. J. Boyle, Jr., president of the company, stated that he saw no reason why they should not and that it was their intention to so employ them in the future.

The two plants employ about 470 people and are manufacturers of oil drums, air receivers, underground storage tanks, and allied products. The concern also manufactures all of its own machinery with the exception of the lathes and electrical equipment.

PERMANENT INTERNATIONAL COMMISSION ON WELDING MEETS AT PARIS

The Permanent International Commission on Acetylene and Autogenous Welding met at Paris on the 20th and 21st of January, 1928. Mr. Edmond Fouche was unanimously elected president of the Commission. The Commission then proceeded to ratify the powers of the delegates from the different countries and pass on the applications for admission of new delegates. It was decided to have the secretary draw up a budget to cover the current expenses and present this to the next session. It discussed the proposition of establishing a statistical research to determine the production and consumption of carbide, oxygen, and dissolved acetylene, and also statistics covering accidents reported to the industry. It was the express purpose of the Commission to establish communication between the specially equipped laboratories of different countries so that these different countries could collaborate with one another in research work for the benefit of the acetylene interests in all countries. Another interesting project was that of establishing a uniform set of conventional symbols for use in designs. Other matters coming before the Commission were ways and means of spreading information to prevent the occurrence of accidents wherever possible, and also to secure wider distribution of literature which would increase the use of the products of calcium carbide.

"STUDENT" MEMBERSHIP OF THE INSTITUTE OF METALS

In order to encourage metallurgical and engineering students, under the age of 23, and those of a similar age working under persons who are qualified for membership of the Institute, to take an interest in their professional society, and to obtain the literature which they require in their studies, there exists a class of members of the Institute of Medals which is known as "Student" member.

"Student" members of the Institute of Metals have all the advantages of full members, with the exception that they have no voting power. They receive, free, the two bound volumes of the "Journal," which are issued annually, and all other publications of the Institute.

"Student members pay an annual subscription of $5 (instead of $15 paid by a full member) and an entrance fee of $5 (instead of $10 paid by a full member).

Application forms for "Student" membership, and a list of 280 members in the United States can be obtained from the Secretary, The Institute of Metals, 36 Victoria Street, London, S. W.

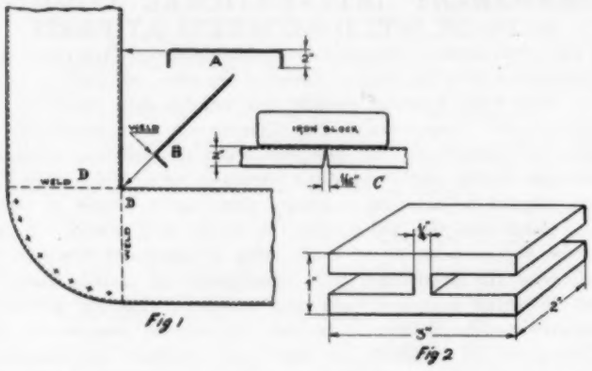
An election takes place on April 11, next. The subscriptions of "Student" members whose forms go forward at this election will cover them until June 30, 1929 and, in addition to the usual two bound volumes of the "Journal" received by them in return for their annual subscription, they will receive a copy of the "Journal" which is to be issued in June next.

PREVENTING BUCKLING OF SHEETS WHEN WELDING

A difficulty every welder encounters when welding steel sheets is from a buckling of the sheets, caused by contraction of the metal when it cools, and unless provision is made to overcome this difficulty the steel sheets may be made useless for the purpose intended.

In making steel counter tops the edges were bent over as shown at A-Fig. 1, but in turning the corner which was rounded it was necessary to weld on a 2" strip as shown at B.

Welding the 2" strip on to the plate caused it to buckle, as shown by x's, all around, so in order to smooth out the buckles a vee about 1/16" long at its base was cut out of the strip where the buckling occurred as shown at C. which allowed the top sheet to be straightened out. An iron block was then laid on top of the sheet and the vees welded together again. The iron block had the effect of conducting away the surplus heat from the plate so that when all the vees were welded up the top plate remained perfectly flat. A method



recommended for work of this nature is to weld on shorter strips at one time and to join them after.

A similar difficulty was experienced in welding the top plates together at D—D. Tacking the plates together every six inches was tried and resulted in the plates buckling so badly they had to be scrapped.

The usual method in welding plates together in this manner is to separate the extreme ends by an opening from 2½ per cent to 4 per cent of the length of the seam, the exact amount of the opening depending on the thickness of the plate and speed of welding, but easily determined by experiment. Then start to weld from the ends which are close together at the other end so that when the weld is completed the plates just meet.

When welding sheets together in this manner the work is made easier by having a jig cut (as shown in Fig. 2) out of a piece of steel. The measurements are shown in sketch.

The jig may be cut out by putting two hack saw blades together suitably spaced and cutting the slot out in one operation. The jig is then inserted between the opening of the plates about 12" from where the weld is started. After about 2" or 3" of the weld is made the jig is moved forward and another section welded and so on all along the seam. The jig will hold the plates together in this manner and allow them to close together without risk of buckling.

CLEVELAND ENGINEERS' EXHIBIT GROWING

More space is being added to the headquarters of the Cleveland Engineering Society this month to give the continuous exhibit of engineering equipment and materials operated by the Society a chance to grow.

The exhibit was started only a little over a year ago as an activity quite new among Engineering Societies, but already the unusual opportunity which the exhibit affords to present new products to the Cleveland engineering market, has attracted so many national advertisers that an expansion program is necessary.

This exhibit is arranged around the sides of a large meeting room, used not only for meetings of the Cleveland Engineering Society but of such organizations as the Production Managers Group of the American Plan Association and local sections of American Chemical Society, American Institute of

Exhibition Room at Headquarters of Cleveland Engineering Society

Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society of Heating and Ventilating Engineers, American Society of Mechanical Engineers, American Society for Steel Treating, American Welding Society and Society of Automotive Engineers, the total attendance running from 500 to 1,000 technical men and industrial executives per month.

When alterations are complete the meeting room will have a capacity of over 300 persons in addition to some 1,800 square feet of display space around the sides of the room. Displays are placed on the floor or arranged on tables of standard design or in glass covered, illuminated display panels on the walls, giving the room a uniform and attractive appearance. Those who visit the rooms consider the displays a very valuable educational feature, giving them an excellent opportunity to learn about new products available for their use.

INTEREST IN CALIFORNIA EXPOSITION GROWS

Increased interest is apparent concerning the Western Metal Congress and the Western States Metal & Machinery Exposition which is to be held January 14, 15, 16, 17 and 18, 1929, at the Shrine Auditorium, Los Angeles, under the auspices of the American Society for Steel Treating. The five days of technical programs are shaping up splendidly and alone are expected to attract to Los Angeles thousands of metal workers from the western states.

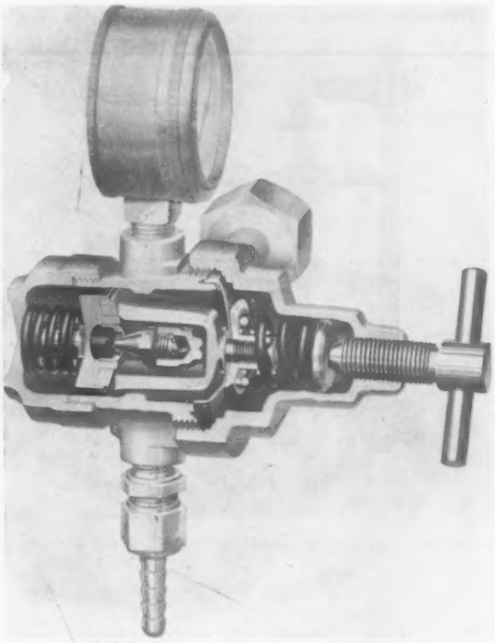
Western sections of the following National Societies and Associations will participate in this congress: American Society of Mechanical Engineers; American Welding Society; American Institute of Mining and Metallurgy; American Petroleum Institute; Society of Automotive Engineers; Pacific Coast Electrical Association; Pacific Coast Gas Association; Institute of Marine Engineers; Metal Trades and Manufacturers Association; Chamber of Mines and Oils; National Purchasing Agents Association; and American Society for Steel Treating.

The Western States Metal & Machinery Exposition, a complete factory equipment exposition for the metal industry, held simultaneously with the congress, will provide an irresistible attraction by displaying metals, machine tools, heat treating apparatus and supplies, inspection equipment, foundry supplies and equipment, materials handling, welding and cutting, oil field tools, machinists' supplies and finished metal products.

NEW REGO X L REGULATOR

The Bastian-Blessing Company, Chicago, Illinois, manufacturers of oxy-acetylene welding and cutting equipment, have recently announced a new model gas pressure regulator described

as the Rego X L. Construction of this new model is illustrated in the accompanying cross-sectional view. Gas enters the regulator at varying pressures up to 2,000 pounds. If the regulator is closed the seat is in contact with the nozzle so gas does not go beyond that point. When the operator is ready for gas he turns the adjusting screw to the right until the gauge connected to the expansion chamber registers the desired flow of pressure. Turning the adjusting screw to the right exerts a pressure on the heavy outside spring, which in turn pushes against the diaphragm, the latter being securely fastened to the seat yoke. The diaphragm moves the seat away from the nozzle, allowing the gas



Mechanism of New Rego Regulator

to flow into the expansion chamber and the incoming gas exerts a pressure against the diaphragm. The gas will naturally continue to flow into the expansion chamber until sufficient pressure is built up to over-balance the pressure of the heavy spring on the opposite side of the diaphragm, thus closing the seat against the nozzle and shutting off the flow. When the torch valve is open the gas flows from the regulator, diminishing the pressure against the diaphragm and allowing the spring to force the seat away from the nozzle a sufficient amount to preheat the incoming gas to keep the balance of pressure against the diaphragm. No dependence is placed upon the spring to close the seat. In the event of foreign material on the seat the resulting excess pressure against the diaphragm will force the seat into the nozzle and stop the flow. The purpose of this construction is to make possible and maintain the delivery of any desired volume of gas at a fixed pressure.

The regulator body is made of extruded forged brass reinforced with a bridge extending entirely across its diameter. All interior parts except the seat are of brass or bronze. The diaphragm is held against a special alloy washer by means of a hexagonal screw bonnet to insure a gas tight joint. A special feature is the large expansion chamber which is used to obtain a smooth flow. The regulator is built with large orifices throughout, with no obstructions to restrict the flow of a large volume of gas. The manufacturers make a special point of the safety features of the construction.

NICHROME WELDING ROD MADE BY DRIVER-HARRIS

Driver-Harris Company, Harrison, N. J., have placed on the market "Nichrome" welding rod. "Nichrome," the nickel-chromium alloy, has been of very great service in the electrical field, for the purpose of converting electrical energy into heat, "Nichrome" wire, ribbon and strip, comprising the vital part of heating units for the most highly developed electric furnaces, ovens, and electrical heating appliances in general. The character of "Nichrome" service in this field, for nearly twenty years, has made it well known for electric heating element performance throughout the world. In the mechanical field, castings of this alloy are used for furnace and oven equipment and for parts of machinery subjected to high temperatures and certain chemical reactions.

"Nichrome" welds have been shown to possess great strength. For example, practical tests of welds on mild steel made with "Nichrome" rods, show an ultimate tensile strength as high as 55,000 pounds per sq. inch. "Nichrome" welds are practically as strong as the original cast "Nichrome." The following table gives the tensile strength of "Nichrome" castings at various temperatures:

Temp. of Test	Ultimate Tensile Lbs. Per Sq. In.	Elongation in 2"	Reduction in Area
20° C.	64,000	3½%	2%
200° C.	59,500	slight	slight
300° C.	56,000	"	"
400° C.	52,000	"	"
500° C.	48,000	"	"
600° C.	43,000	"	"
700° C.	38,500	"	"
800° C.	30,000	2½%	4%
900° C.	20,000	7½%	9%
1000° C.	12,000	15%	16%
1100° C.	6,000	20%	18%

The physical characteristics of "Nichrome" include resistance to corrosion when in contact with strong acids and alkalies, low co-efficient of expansion, resistance to oxidation at temperatures up to 2000° F. "Nichrome" welds retain strength to a remarkable degree when subjected to high temperatures, the melting point being over 2500° F. They are readily machinable and may be made by either the oxy-acetylene or arc welding process.

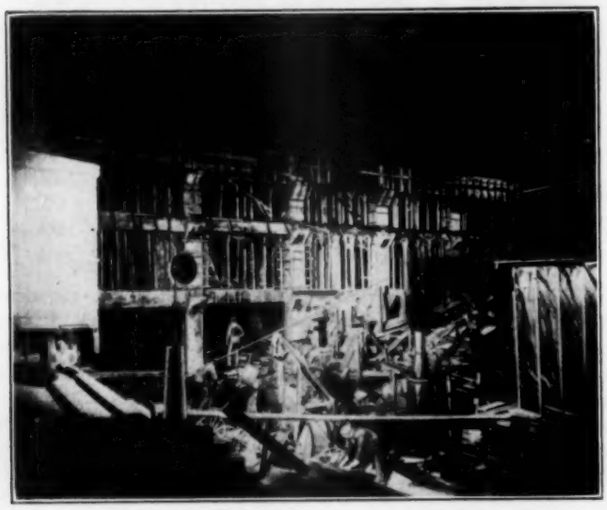
STOODY COMPANY ISSUES BOOKLET ON BORIUM

A twenty-four page booklet recently issued by the Stoody Company, Whittier, California, gives an interesting description of the use of their product, Borium, which is a substitute for diamonds, in the tips used in oil well drilling. Borium is a manufactured product of uniform size and composition with hardness between that of a sapphire and a diamond. It cannot be melted in the hottest part of the oxy-acetylene flame but other metals such as iron and steel and facing materials can be brazed or fused to it. It is therefore possible to apply this new material to the cutting edges of oil well bits by the use of the oxy-acetylene torch to melt the metal on the face where the Borium is to be inserted. The material comes in three forms, either in round rods or in small irregular sizes called pea sizes, or in small sizes enclosed in a cylindrical jacket of mild steel $\frac{5}{16}$" in diameter. It is comparatively easy to apply this material when furnished in tubes because the tube itself is melted off in practically the same fashion as an ordinary filler rod and the Borium is supplied just where it is wanted. Since the material in which this hard substance is imbedded will often wear away, leaving the Borium exposed, it is recommended that it be covered with a hard facing material which will hold it more firmly in place and protect it for a longer period of service. It is not necessary, however, to use large quantities of Borium on a tip. After the metal around it has been worn away, the remaining pieces of the Borium can be reclaimed and used again by melting the surrounding metal. It is said that several oil tool supply companies are at present designing special bits in order to fully take advantage of the unusual hardness and cutting qualities of Borium. The booklet mentioned contains numerous illustrations showing the appearances of Borium in its different forms, different types of tools which have been faced with it, and the method used in applying it.

A PORTABLE LIGHTING UNIT

A portable acetylene flare light has been added to the line of the Oxweld Acetylene Company, 30 East 42nd Street, New York City. This flare light is extremely powerful and has many outstanding features as a portable lighting unit.

The fuel used is acetylene, produced from Carbic. This material is in the form of cakes of uniform size and cylindrical shape, Several cakes of Carbic, enough to operate the flare continuously for 12 hours, can be placed in the light at one charging. If the use of the light is discontinued before the entire charge is used, the portion remaining can be left in the holder, or, being dry, solid and clean, can be slipped back into the drum for later use. The operating cost of this light per hour of service is very low. This flare light is said to operate equally well under all climatic and weather conditions. It is equipped with a storm-proof burner, permitting its use even in violent gales. Construction is rugged



The Carbic Flare Light in Use on Construction Work

and simple. There are but three parts, and these cannot be incorrectly assembled. Charging is a one-man job which requires only a few minutes. When the light has been put into operation it needs no further attention until the charge is exhausted.

An automatic feed allows water to come into contact with the lowest cake of Carbic until sufficient acetylene is generated to drive the water out of the gas bell to a level below the bottom of the cake. This process is continually repeated during the operation of the light and gas generation is uniformly and safely maintained at a pressure of less than 1 lb. per sq. in. The Carbic never rests on a pad of sludge since the residue settles to the bottom of the water.

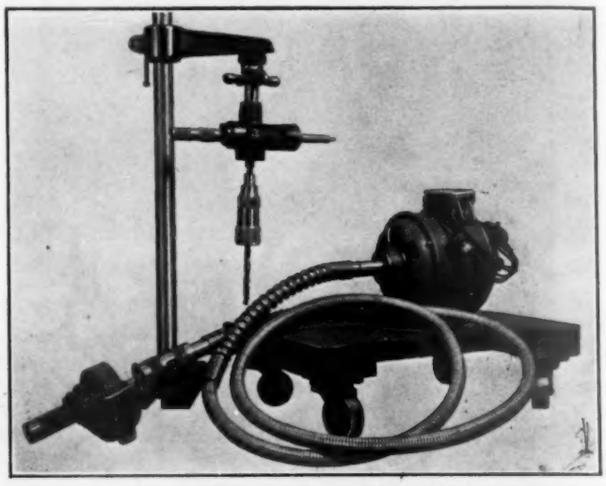
In case the light is accidentally upset, the water runs out of the container and gas generation stops immediately. This light, because of its power and dependability, is suitable for subway and tunnel operations and night work of all kinds including: stock piling, excavating, building construction, paving, loading cargo aboard ship, and harvesting ice.

Carbic flare lights are manufactured by the American Carbolite Company, Inc., and Oxweld Acetylene Company, New York City, are sole distributing agents. Carbic, the fuel used, is marketed exclusively through Union Carbide Sales Company, New York City. The Carbic light is available in several styles, each of which is entirely self-contained. They range in size from the 8000 candle-power "Standard" model, which weighs 36 lb. empty, and 115 lb. charged and stands 6 ft. 7 in. high with reflector raised, to a hand light. A double burner model, which will furnish illumination in two directions simultaneously, is furnished in about the same size as the "Standard" model.

BIAX FLEXIBLE SHAFT EQUIPMENT

Biax Flexible Shaft Company, Inc., 20 East 17th Street, New York City, has placed on the market a complete line of flexible shaft equipment, for such purposes as grinding, buffing, scratch finishing, polishing, sand papering, die sinking, cleaning of castings, and all types of drilling. The grinding of welded joints is one of the important operations that machines of this type perform very economically. The driving units vary in power from 1/16 to 5 H. P. and in speed from 1000 to 4000 R.P.M. The shafts range in size from 0.137 to 1.18 inches.

The illustration shows a complete assembly of a single speed



Complete Grinding Assembly With Biax Flexible Shaft.

motor, mounted on a portable truck, with a ten foot flexible shaft, and ball bearing hand piece. This ball bearing hand piece carries a standard inner Morse taper No. 1, allowing quick interchangeability of tools and complete universal application. An outer ball bearing hand piece with grinding wheel and protection cover are attached to the shaft. The gear reduction grinding head mounted on an "old man" is a convenient added accessory, since it is capable of drilling up to one inch in steel.

RAIL WELDING SERVICE FOR RAILROADS

The Electric Rail Weld Service Corporation, Chicago, Ill., has recently been organized to furnish railroads what is known as the Teleweld process of rebuilding rail ends electrically. The plant used for the application of this process consists of a portable gasoline driven generator which travels over the rail under its own power and an electrically driven grinding machine which finishes the weld. The main plant is set off the rails in the clear of traffic and one mile of track is welded at each point. When the set up is made the first procedure is to apply straight edges to the rail ends across the joint gaps and mark rail for welding. Then all worn, fatigued or laminated metal is removed from the rail ends. New metal is then welded to the gap and also applied to depressions back of the joint gap. Excess metal is then removed by grinding both longitudinally and diagonally. The process was demonstrated at the recent exposition of National Railway Appliances Associations in the Coliseum, Chicago.

A. W. S. WELDING INSTRUCTION MANUALS IN BOOK FORM

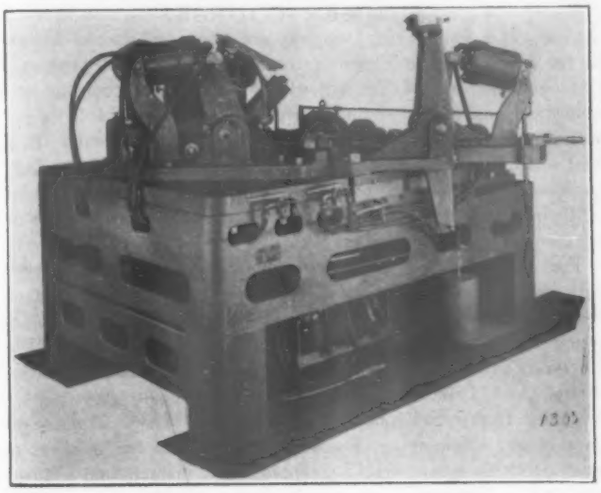
During the past year issues of the Journal of The American Welding Society have contained instruction courses in the four principal welding processes. These instruction manuals were intended to be produced later, separate from the journal, so that they would be available for people interested in training operators. Now these four training courses have been brought together into a single volume in a handsome flexible imitation leather binding

and are being sold by the American Welding Society, 33 W. 39th St., at $2.50 per copy. Individual copies of instruction manuals are available in paper binding at $.50 per copy for courses in either electric arc, oxy-acetylene, or thermit welding, and $.35 per copy for a course in electric resistance welding. A letter from the Society states that special rates are made when these manuals are ordered in quantity lots. The manuals have all been prepared as the result of work of committees composed of well known authorities in the welding industry.

THOMSON ANNOUNCES MODEL NO. 41 BUTT WELDER

This welder was designed primarily for automobile body manufacturing in the welding of two pieces of automobile stock .053 inch thick. The parts to be welded are the cowl and another part which forms the front post for the windshield. This latter part is joined to the formed part while it is in the flat.

The frame is of cast iron and of not very heavy construc-



Thompson Model No. 41 Butt Welder.

tion, as only light pushup pressures are required. The clamps on the right platen are made in two separate units and their brackets form two sub-platens which are mounted in such a way as to obtain the necessary accurate alignment of the welding dies. Each half clamp may be adjusted independently of the other. The clamping jaws and levers are brought into position by hand and then the final clamping pressure applied through air cylinders—the control valves for which are mounted at the front of the welder. When the air pressure is released, the clamps are unlocked by hand and counterweights then cause them to open. Various types of clamps can be supplied on this same frame.

The pushup mechanism and drive mechanism consist of a 3 HP. motor connected to a reduction gear unit and through spur gearing to a cam shaft which gives a ⅝-inch platen travel, although somewhat greater travel could be obtained if desired. Return of the right platen to a starting position is obtained by means of an air cylinder. Adjustment is provided for varying the starting open position of the platens. The platen width on this welder is sufficient to permit welding material as wide as 54 inches.

The transformer capacity is 200 KVA., consisting of two separate 100 KVA. water cooled transformers mounted beneath the welder frame.

HOLLUP APPOINTS W. E. VAN DRESSER WISCONSIN REPRESENTATIVE

The C. H. Hollup Corporation, 3333 W. 48th Place, Chicago, Illinois, Manufacturers of Welding Wire, Welding Accessories and Electric Arc Welding Machines, announce the appointment of Mr. W. E. Van Dreser as their Wisconsin Sales Representative, with headquarters at 223 Metropolitan Block, Milwaukee, Wisconsin, Telephone Grand 267.

W. E. Van Dreser.

Mr. Van Dreser will continue as Minnesota representative for the C. H. Hollup Corporation and will maintain a branch office in the Sexton Building, Minneapolis, Minnesota, Telephone Geneva 5064.

Mr. Van Dreser has had a long and varied experience in connection with the sale and application of electric arc welding, machines and supplies, his experience dating back to 1918, at which time he went with the Lincoln Electric Company as District Manager of their Minneapolis office. At that time, and before starting active work in Minneapolis for the Lincoln Electric Company he spent four months in their factory at Cleveland.

In July, 1926 Mr. Van Dreser resigned from the Lincoln Electric Company to take over the sale of the electric arc welding machines manufactured by the U. S. Light & Heat Corporation and the Welding Wire and Accesories as manufactured by the C. H. Hollup Corporation.

In November, 1927, Mr. Van Dreser resigned his connection with the U. S. L. Company, deciding to devote his entire time to the sale of Hollup products, including the Hollup Arc Welding Machine.

Mr. Van Dreser has moved his residence to Milwaukee and will make that city his headquarters, but will spend part of his time in Minneapolis where he will maintain a branch office.

BOOKLET ON ACETYLENE AND CITY GAS AS FUELS FOR CUTTING

The relative value of acetylene and city gas as fuels for cutting iron and steel with oxygen is the subject of the booklet now being distributed to interested engineers by the International Acetylene Association.

This subject is considered both from the standpoints of theory and practice. In one comprehensive study by J. K. Mabbs of the Union Carbide Sales Company, New York, the laboratory aspects of this question are discussed in detail. J. L. Anderson, National Carbide Company, New York, discusses the matter from the standpoint of the shop man, basing his conclusions upon the experience of a large number of concerns who have tried both acetylene and city gas as cutting fuels over appreciable periods of time on commercial cutting operations.

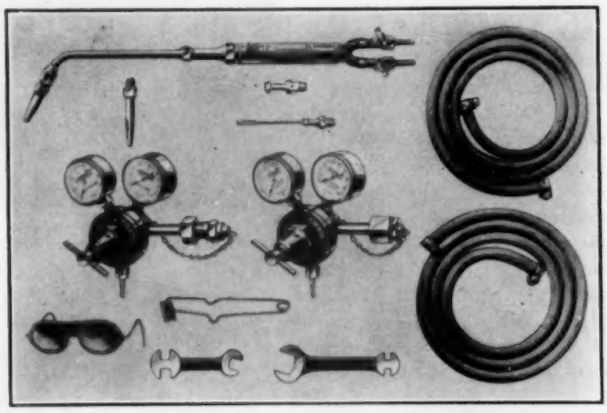
The data contained in this booklet should be of value to engineers, plant managers and others who desire information on the subject and who may be considering the efficiency of one gas or the other as a cutting medium. Copies can be obtained by addressing the office of the Secretary, International Acetylene Association, 30 East 42nd Street, New York City.

THREE NEW PREST-O-WELD WELDING OUTFITS

Especially to meet the demand of automobile repair shops and sheet metal shops for low-priced assemblies, three Prest-O-Weld welding outfits, designated as the Type W-101-A Auto Repair Outfits, the Type W-102-A General Purpose Outfit, and the Type W-102-B Welding Outfit, have been placed on the market by the Oxweld Acetylene Co., 30 East 42nd Street, New York City.

These outfits are made possible by the addition to the Prest-O-Weld line of two small, two-gauge regulators, Types R-106 and R-107, and two special blowpipe tips, one for heating and brazing and one for radiator soldering.

The Type W-101A Auto Repair outfit is for the garage that has only an occasional welding job but needs a large-size blow-



Type W-101-A. Auto Repair Outfit.

pipe for frame straightening. For this purpose a No. 10 tip is included which is also suitable for reasonably heavy welding operations. A No. 6 Tip is provided for every-day welding jobs. A special heating tip and a radiator soldering tip, which consume acetylene only, are designed for light heating, brazing and soldering operations. The radiator soldering tip enables the operator to solder the leaves of a radiator in places that would be inaccessible with any other type of tip.

The Type W-102-A General Purpose Outfit is for any repair shop that wishes to employ the oxy-acetylene process in all of its many applications—welding, decarbonizing, heating, soldering, brazing, lead burning and radiator repair. Five welding tips and a decarbonizing blowpipe, as well as the heating and radiator soldering tips, are included in this outfit.

The Type W-102-B Welding Outfit is recommended for auto body and fender work and for welding light and medium castings. It is also suitable for the sheet metal shop and for light production welding such as skylight and cornice work, building sheet metal furnaces, fabricating tanks and steel barrels, welding the corners of steel sash window frames and similar work. This outfit, which includes five welding tips, is particularly adapted to production processes because the light weight of the blowpipe with its 3/16 in. hose does not tire the operator even on continuous work.

By the addition of a cutting attachment any of these three outfits may be used for cutting wrought iron or steel.

LINCOLN HAS NEW BOOKLET OF ARC WELDING ACCESSORIES

A new eight page booklet recently issued by the Lincoln Electric Co., Cleveland, Ohio, manufacturers of arc welders and arc welding supplies, describes and illustrates a complete line of accessories for all types of arc welding applications. This includes illustrations and descriptions of special electrodes for electric arc welding and trucks for portable outfits.

BOOKLET DESCRIBES DIRECT CURRENT WELDING EQUIPMENT

A booklet describing features incorporated in the Dualarc Welder has recently been published by the Electric Arc Cutting and Welding Company of Newark, New Jersey.

The Dualarc Welder, according to the booklet, can be operated as either compound or differentially wound generator, a feature which gives high efficiency using either the metallic or carbon arc. These welders have a separate control of voltage and amperage, giving any welding heat desired. They can also supply either direct or alternating current.

In addition to the Dualarc, this company also manufactures the Alternarc Welder, alternating current welding equipment; as well as Newarc Electrodes and Electrode Holders, Newarc Welding Helmets, and other accessories and equipment. C. J. Holslag, general manager of the company, is author of "The Welding Handbook," a valuable instruction manual on welding, for both the beginner and the practical welder. It is planned to publish extracts from this book as well as instruction leaflets, which will be sent to customers and others interested in welding.

WELDING INCLUDED IN CARNEGIE SUMMER COURSES

Courses in engineering subjects are receiving special attention in the plans for the Eleventh Summer Session this year at the Carnegie Institute of Technology in Pittsburgh, according to an announcement. The summer work is being outlined to cover both theoretical class room instruction and shop practice, to appeal not only to the undergraduates, but also to those engaged in engineering work who feel a need for more technical training in their respective fields. Courses of six and eight weeks will be given, beginning June 11.

The College of Engineering, according to the announcement, will give summer courses in Chemistry, Physics, Mechanics, Surveying, and Coal Mining. In the College of Industries, courses are scheduled in Plumbing, Welding, Sheet Metal Work, Machine Practice, Woodworking and Cabinetmaking, Electric Wiring and Printing. Other departments will give work in English, History, Economics, Commercial Law, Mathematics, Psychology, Engineering, Drawing, and courses for teachers and supervisors in music, fine and applied art, manual and industrial art, and architecture.

News of the Welding Trade

At the monthly meeting of the Victorian Institute of Welding Engineers, Melbourne, Australia, which was held in the main lecture room of the Workingmen's College, February 23rd, an illustrated lecture on the subject of "Pioneering in Modern Electrically Welded Structures" was read by Mr. H. E. Grove.

Mr. R. P. Dieckelman has been made Vice-President of the Pressed Steel Tank Company, Milwaukee, Wisconsin, and Mr. Herman Merker has been made secretary and sales manager of the company. Both Mr. Dieckelman and Mr. Merker have been identified with the Pressed Steel Tank Company for a good many years and are very well known throughout the trade.

A quantity of Steere welded steel pipe will be installed in the plant of the Texas-Louisiana Power Company of Pecos, Texas. The Semet-Solvay Engineering Company of New York has been given an order for exhaust, muffler and intake pipe. Part of the material will be galvanized. Steere welded sleeve joints are specified, which will eliminate flanges.

At the monthly meeting of the American Welding Society, Pittsburgh Section, held at the William Penn Hotel, February 9th, Mr. George J. Green of the Pittsburgh Welding Corporation spoke on the subject of "Miscellaneous Welding and Repair Work."

The Advantages of Tobin Bronze Welding

ANACONDA
from mine to consumer

Tobin Bronze is unequalled for welding cast iron by the oxy-acetylene process. It has the following advantages:

The base metal need only be heated to a dull red as Tobin Bronze flows freely at 1650° F.

This low welding temperature eliminates special pre-heating and often makes dismantling unnecessary.

Shrinkage can be prevented and the original alignment of broken parts retained.

And most important of all, Tobin Bronze is stronger than cast iron.

Tobin Bronze Welding Rods are made solely by The American Brass Company and "TOBIN BRONZE" is stamped in the metal.

THE AMERICAN BRASS COMPANY
GENERAL OFFICES: WATERBURY, CONNECTICUT
Offices and Agencies in Principal Cities
Canadian Mill: Anaconda American Brass Ltd., New Toronto, Ont.

TOBIN BRONZE
REG. U.S. PAT. OFF.
WELDING RODS

"STANDARD"
Welding Wire
GAS AND ELECTRIC

for sound permanent welds : : lower costs
Our costs are considerably under those of large industrial centers; ours is a one-profit wire sold direct to user from our own mills exclusively devoted to making of welding wire from raw material to finished product—hence our extremely low prices for wire that is definitely superior. Adopted exclusively by many large users.
Prices on request.

A grade for each type of work—send for samples. Standard Steel & Wire Co., Greensburg, Pa. (Mills at Bolivar, Pa.)

The Lincoln Electric Company, Cleveland, Ohio, announces the transfer of Mr. John Van Horne from the Atlanta office to Moline, Illinois, where he will have headquarters at 514½ Fifteenth Street.

L. W. O'Day is manager of a new organization called Arc Welder Sales, dealing in new and used electric arc welding equipment, with headquarters in Room 435 Burnham Building, 160 North LaSalle Street, Chicago, Illinois. Mr. O'Day calls attention to the fact that the organization is in the market for used equipment.

It is reported that the Magnolia Gas Products Company is now at work on the erection of a new oxygen plant in San Antonio, Texas, which is expected to be completed within sixty days. The company now has plants at Houston, Texas and Beaumont, Texas.

The Purox Company of Denver, Colorado announces the opening of a district sales office at 618 Railway Exchange Building, Chicago. This office will be in charge of Mr. M. H. Turner, formerly district manager of the Purox Company at Cleveland, Ohio.

E. D. Findlay, President of the Acme Oxy-Acetylene Company, Chicago, Illinois, has just returned to his duties after a short sojourn at White Sulphur Springs, which was made necessary by a rather serious illness.

The Lincoln Electric Company of Cleveland, Ohio announces the appointment of Mr. O. D. Fries as salesman in charge of consumer motor business in the Detroit territory under the direction of Mr. J. M. Robinson, District Manager in the Detroit district.

A new one-story plant is to be erected by the Corpus Christi Boiler, Welding and Machine Works, 716 Carrizo Street, Corpus Christi, Texas. It is reported that this will be a $30,000 plant when completely equipped.

Friends of Harold Cook, formerly editor of the Acetylene Journal and Secretary of the American Welding Society, Chicago Section, will be interested to learn that Mr. Cook addressed the Advertising Club of New York on March first on the subject of the relations between business papers and advertising agencies. Mr. Cook is now associated with the Philadelphia office of N. W. Ayer & Son, one of the best known advertising organizations in America.

Jim Farnan of Bridgeport, Connecticut, has joined the Storts Welding Organization at Meriden, Connecticut, and effective March first he will be in charge of the welding supply division.

Among the recent new corporations in the commercial welding field is the Paterson Welding Company, which has recently been organized at Passaic, New Jersey.

Announcement has been received of the removal of the Phoenix Welding Machine Company, Jersey City, N. J. from 389 Montgomery Street, to larger quarters at 405 Montgomery Street.

REBUILT WELDERS
We specialize in guaranteed rebuilt
ARC WELDERS
SPOT WELDERS
Goodman Electric Machinery Co.
Newark New Jersey

Classified Ads

Help Wanted—75c per line, minimum 4 lines.
Jobs Wanted—4 lines free.
Other Ads—$1.00 per line, minimum 4 lines.
Counted 8 words to line. Add 6 words for keyed address.

Wanted—Large Wire Manufacturer desires the services of first class welding engineer, or a high class welding wire salesman. In reply give full information as to experience, references, salary expected, etc. Reply will be held confidential. Address Box 148, care of The Welding Engineer.

Wanted—Used electric welding outfits in first class condition. Also Rego acetylene equipment, and parts for same. Apply Box 150, care of The Welding Engineer.

For Sale—G. E. arc welder, portable, complete, 200 ampere for 220-3-60 power. Address Box 149, care of The Welding Engineer.

One Dollar will increase your earning power by bringing you any one of the following FLUX FORMULAS—cast iron, brazing, copper, nickel, high speed steel, aluminum (sheet and cast). Now make you own up fresh. R. N. Robbins, 38 Winans Street, East Orange, N. J.

Salesmen Wanted—To sell acetylene generators and torches on straight commission in territory West of the Mississippi. The Brooks Machine Company, Wichita, Kansas.

Position Wanted—Supervisor, demonstrator or sales and service representative. 9 years experience in oxy-acetylene welding. Knows every variety of work. Willing to go anywhere on promising opening. Address Box 151, care The Welding Engineer.

Position Wanted—By welder with 12 years' electric arc and gas welding experience. Can qualify as shop foreman and can read blue prints and lay out structural steel and tank shop work. Experienced on production work. Can give references. Will go anywhere. J. E. McLausson, 2711 Throck Morton Street, Dallas, Texas.

ELECTRIC ARC WELDERS WANTED:

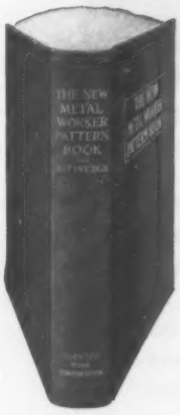
Men thoroughly experienced in electric arc welding; must be familiar with pressure work. Applications by mail should contain full details of experience and references. Pacific Steel Boiler Corporation, Bristol, Pennsylvania.

For Pipe Welders!

The New

Metal Worker Pattern Book

By GEO. W. KITTREDGE and Associates



This work is the standard reference on all phases of pattern drafting and is recognized as the most practical and thorough text book on modern methods of developing and cutting patterns for sheet metal work and templates for pipe cutting. It covers the principles underlying practically every problem that is likely to come up in daily practice. No better text book for home study has ever been published.

This new edition has been carefully revised and brought up to date. The instructions for making pipe cutting patterns are especially valuable.

CHAPTER HEADINGS

Terms and Definitions.
Drawing Tools, Materials
Linear Drawing
Geometrical Problems
Principles of Pattern Cutting
Pattern Problems

9x11 *inches. Cloth Bound.*
534 *Pages.* 895 *Illustrations.*
Price $6.00 *Postpaid.*

The Welding Engineer Publishing Co.
608 S. Dearborn St. Chicago, Ill.

Uniformity means *Economy*

Uniform temper, uniform analysis, uniform gauge and finish, all help to make "Seneca" the dependable, economical rod that it is.

"Seneca Gas Weld"
"Seneca Electro Weld"

are made from specially selected stock by our own processes. They are produced as Special Soft, Medium Hard, and Extra Hard, shipped in coils or straight lengths, in—

Black—Bright—Coppered Finish
Flux Coated

Your inquiries will receive prompt attention

AGENTS WANTED—COMMISSION BASIS

The Seneca Wire Mfg. Co.

Established 1905

Fostoria **Ohio**

Arc Welding Handbook

BY C. J. HOLSLAG

A simple and practical manual of instruction in arc welding. The beginner is led step by step to complete mastery of the process. The supervisor is furnished a reliable guide for the training of new operators. The experienced operator is posted on principles which were overlooked in his first teaching.

250 Pages

Well Illustrated

Price, $2.00

The Welding Engineer
Book Dept.
608 S. Dearborn St., Chicago, Ill.

Whether you are now using low carbon rods or expensive alloy rods, it will pay you to try—

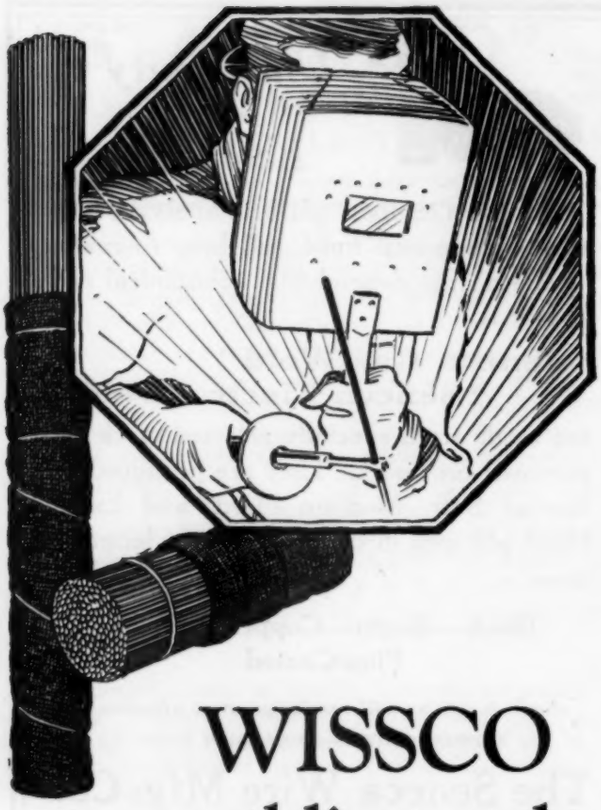
Genuine Swedish Iron

If you have been using alloy rods because domestic low carbon did not give results, Genuine Swedish Iron will solve your welding wire problem. You can avoid the difficulties of other low carbon rods, at a lower cost than alloy rods.

Its fine working qualities, and the *strength* and *ductility* of the welds, are the result of using an iron practically free from impurities.

If you haven't tried Genuine Swedish Iron, send us a trial order.

THE BISSETT STEEL COMPANY
CLEVELAND **OHIO**



WISSCO
welding rods

Electric and Gas Welding

Wickwire Spencer offers you—not only welding rods PRE-TESTED and of HIGHEST PROVEN QUALITY—but places subject to your call an engineering and metallurgical department with a true perspective on manufacturing and welding costs.

Our welding engineers, if it is desired, can help you select proper welding stock. They have a thorough knowledge of factory and production welding costs which is offered to you in the interest of economical welding and better results.

MAKE YOUR PROBLEMS OURS

Wickwire Spencer Steel Company
41 East 42nd St.
New York City

WICKWIRE SPENCER STEEL CO

WICKWIRE SPENCER PRODUCTS

Big Jim (Master Welder) says:

Leave it to FRE-FLO Welding Rod if you want a job you can *machine*. FRE-FLO cuts just like the original casting. No hard spots—no sand. Every rod clean clear through. That's because FRE-FLO is *pure* pig—nothing else.

[How about a sample of FRE-FLO? Just ask for it!]

Big Jim (MASTER WELDER)

FRE-FLO rods are sold only through distributors. A few desirable territories are still open. Correspondence from distributors is invited.

The Atlas Foundry Company
Department "B"
W. 69th & W. & L. E. Ry. Cleveland. O.

WHARTON
Standard Seamless Steel Cylinders

for—

OXYGEN
HYDROGEN
LIQUEFIED PETROLEUM GAS

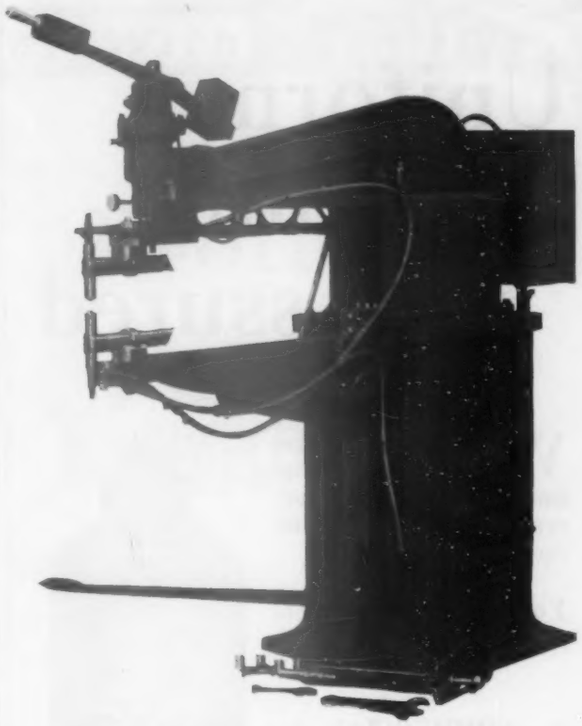
Interstate Commerce Commission Specifications

William Wharton Jr. & Co., Inc., Easton, Pa.
Cylinder Sales Office: 110 E. 42nd St., New York

Save Time and Money

SHEET metal parts are being adapted to industry everywhere. The old, slow, and more costly method of riveting is becoming obsolete. Spot welding is replacing riveting with consequent saving in time and money. Why do you not thoroughly investigate the possibilities of adapting spot welding to your work?

Because of the extensive experience of Federal Engineers in welding, they can quickly and freely advise you as to the proper type of welder for your needs. Federal makes all kinds of electric spot, butt and seam welders.



Type 444 Heavy Duty Spot Welder
Drop Arm, Universal Holders, 1¼ in. Points

THE FEDERAL MACHINE & WELDER CO.
Dana Avenue Warren, Ohio
Branch Offices in All Principal Cities

There's More Welding in the K-G Torch

K-G Torches have a high rating for real value because they have such long welding life. Because of the simplicity of design and careful selection of materials they are practically everlasting, and perfect proportioning of the gases makes them free from injurious flashbacks. You don't know what good strong torch construction can do to keep down your welding costs until you have given the K-G a thorough trial.

A Standard K-G Welding Unit—Every Part Dependable

Three requirements of K-G Apparatus are: It must eliminate waste of gas and time; it must be made for hard service; and it must be perfectly safe under all operating conditions.

K-G WELDING & CUTTING CO.
INC.
515 West 29th St.
Phone Chickering 0996-7-8
New York City

Scientific Simplicity Gives More Value at No Greater Cost

Uniform Quality Assured

WELDERS who use Commercial Acetylene soon learn that every cylinder contains the same pure gas.

Your torch can tell the difference!

COMMERCIAL ACETYLENE
Means pure acetylene.

COMMERCIAL SERVICE
Means prompt service.

No matter what your gas requirements may be you will be interested in our sales plan. Ask our nearest office to tell you about it.

Supplied in the following size cylinders:

10x30-in. size	125 cu. ft. cap.
12x36-in. size	225 cu. ft. cap.
12x44-in. size	275 cu. ft. cap.

Commercial Acetylene Supply Company, Inc.

General Office: 71 Broadway
New York City

BRANCHES:

600 W. Jackson Blvd.
Chicago, Ill.

708 Thrower Bldg.
Atlanta, Ga.

683 Atlantic Ave.
Boston, Mass.

417 Market Street
San Francisco, Calif.

PAGE

Processed

WELDING WIRE *and* ELECTRODES

5 standard grades for all ferrous welding

1 PAGE-ARMCO
2 PAGE "B"
3 PAGE "C"
4 PAGE "H.C."
5 PAGE "L.C.S."

PLAINLY MARKED
SHOP TESTED
UNIFORM
PROCESSED

Any welder can prove these better points of Page Welding Wire and Electrodes for himself in his own shop IN HIS OWN WAY. Your name and address brings samples.

Page Steel and Wire Company
Bridgeport, Connecticut

DISTRICT OFFICES:
Chicago New York Pittsburgh
San Francisco

An Associate Company of the American Chain Company, Incorporated, Bridgeport, Conn.

You Can Do It Better With TORCHWELD

STOP These Expensive Losses with Torchweld Non-Flash Torches.

Loss of production directly caused by flash-backs.

Loss of production caused by the operator being compelled to favor a flashing torch.

Loss of time while shutting off and relighting the torch.

Loss of heat during readjustment of flame as material must again be brought to a molten condition.

"SAVE" Time, Gases and Maintenance Expense by using Torchweld Non-Flash Equipment. "Let us prove it."

for

Profits

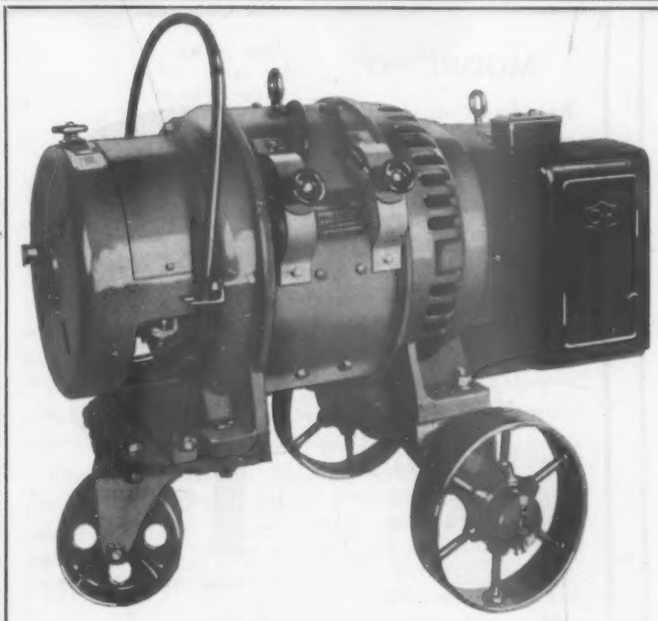
use

TORCHWELD

The Standard of Comparison

GET THE FACTS. Write for Catalog No. 28

TORCHWELD EQUIPMENT COMPANY
224 N. Carpenter St. CHICAGO



A Welder So Different
It Merits Investigation

No Exciter—
No External Stabilizer—No Rheostat
—One Control—

Arc Flexibility Hitherto Unapproached
Welding Range Never Before Equaled

Lowest First Cost
Lowest Operating Cost

EQUIPMENT-SUPPLIES FUZON WELDING & CUTTING

FUSION WELDING CORPORATION

Engineers — Manufacturers — Merchants

103RD STREET AND TORRENCE AVENUE, CHICAGO

When buying CARBIDE — Ask for NATIONAL

BEST for All Industrial Purposes

—

IN THE RED DRUM SAVES YOU MONEY

—

Warehouses in All the Principal Cities

National Carbide Sales Corporation, 342 Madison Ave., N. Y.

Now in full production with

"KORO"
(Patent applied for)

ELECTRODES

The improved production facilities in our new plant enable us to furnish KORO electrodes in any volume at prices which are distinctly attractive. The quality of the electrode is uniformly good, and the KORO processing and coating give it the rapid working quality which is so necessary in production work as well as repair work.

Send a trial order for some KORO wire from the new plant.

KORO CORPORATION
WAUKEGAN, ILLINOIS

A complete line of gas and electric welding wire.

MODEL "O"

has been designed to give the welder a maximum of comfort and protection embodied in the extreme lightness of weight, proper ventilation and the absolute exclusion of all outside light.

MODEL "O"

is made throughout of special vulcanized fibre of exceptional strength and wearing qualities. This shield carries the CESCO indorsement; your assurance that the degree of quality and workmanship is of the highest.

Model "O" Handshield

PRICE

Complete with ESSENTIALITE Lens
$5.00 *each.*

Manufactured by

Chicago Eye Shield Company
2300 Warren Ave., Chicago, Ill.

American Steel & Wire Company's

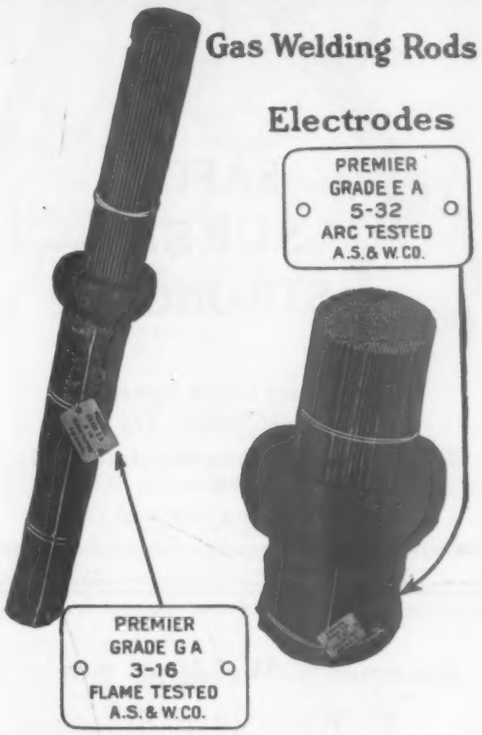
PREMIER

TESTED

WELDING WIRES

Gas Welding Rods

Electrodes



PREMIER Welding Wire flows freely, giving perfect fusion, thorough penetration and the desired finish. The uniform quality of Premier Welding Wire insures a deposit of metal in the weld free from foreign inclusions and possessing maximum strength. Before shipment, every bundle is electrically tested and manually welded. Permanently satisfactory welds and a saving of gas, electricity and the welder's time are thereby assured.

For a dependable welding job, use an appropriate grade of Premier Welding Wire. Send for booklet giving full information and specifications.

American Steel & Wire Co.

SALES OFFICES

CHICAGO	208 So. La Salle St.	NEW YORK	30 Church St.
CLEVELAND	Rockefeller Bldg.	ATLANTA	101 Marietta St.
DETROIT	Foot of First St.	WORCESTER	94 Grove St.
CINCINNATI	Union Trust Bldg.	BALTIMORE	32 So. Charles St.
MINNEAPOLIS—ST. PAUL	Merchants Nat'l Bank Bldg., St. Paul	BUFFALO	670 Ellicott St.
ST. LOUIS	506 Olive St.	WILKES-BARRE	Miners Bank Bldg.
KANSAS CITY	417 Grand Ave.	DALLAS	Praetorian Bldg.
OKLAHOMA CITY	First Nat'l Bank Bldg.	DENVER	First Nat'l Bank Bldg.
BIRMINGHAM	Brown-Marx Bldg.	SALT LAKE CITY	Walker Bank Bldg.
MEMPHIS	Union and Planters Bank Bldg.	*SAN FRANCISCO	Russ Bldg.
BOSTON	Statler Bldg.	*LOS ANGELES	2087 E. Slauson Ave.
PITTSBURGH	Frick Bldg.	*PORTLAND	6th & Alder Sts.
PHILADELPHIA	Widener Bldg.	*SEATTLE	4th Ave. So. & Conn. St.

*United States Steel Products Company

Imperial

OXY-ACETYLENE

Welding and Cutting Equipment

IN EVERY industry where machinery or metals are used, astounding things are accomplished with Imperial Welding and Cutting Equipment.

Parts worn so thin as to seem utterly beyond repair are quickly built up to proper size; crushing rolls, battered and chipped are quickly returned to service as good as new; broken gears and flywheels weighing tons are reclaimed at a fraction of the cost of new ones; parts of castings and machinery broken off are put back on—and in all these operations, the welded part is actually stronger than the original.

But, besides its value as a repair tool, Imperial Welding Equipment is daily finding new uses in manufacturing processes. There are literally thousands of production operations that can be done better, quicker and more economically by Imperial Oxy-Acetylene Welding than by any other method.

Let our engineers suggest the proper equipment for you.

IMPERIAL BRASS MFG. CO.
522 So. Racine Ave.

Don't Use Costly Gas and Time Getting a Neutral Flame

The WELDIT GASAVER

Saves That Useless Cost

ONE flame adjustment lasts all day. Torch is hung on hook when not in use, and no gas is burned. A pass of the torch tip over the pilot light gives you the neutral flame you had before. Savings as high as 40% have been reported. It's a safety device, too. An automatic check valve keeps flash-backs from reaching hose or regulators. The Gasaver can be used with any type of apparatus.

Approved by
National Board of Underwriters
Licensed Under Basic Patents

WELDIT

Welding Torches
Cutting Torches
Regulators
Lead Burning Equipment
Welding Wire
Welding Goggles
Cast Iron Rods
Welding Hose
Brazing Wire
Fluxes & Solders
Safety Gloves
Service

WELDIT ACETYLENE CO.

634 Bagley Ave. DETROIT, MICH.

DON'T STRIKE A MATCH

SHOOT-A-LITE

See the safe distance of hand from flame

SAFE!
SURE!!
STRONG!!!

The finest torch lighting device ever made. Try it.

STEVENSON DISTRIBUTING CORPORATION
(*Sole Owner*)
119-121 E. 27th St., New York City

INDUSTRIAL GASES

I.O.C. SYSTEM

OXYGEN HYDROGEN
ACETYLENE NITROGEN
PRIMOGAS

GENERATING APPARATUS

Cylinders—Valves—Regulators
Eyesee and International Welding and Cutting Torches
Welding Wire—Fluxes
Cast-Iron and Aluminum Rods
Plain and Armored Rubber Hose
Asbestos Pads and Paper Goggles, etc.

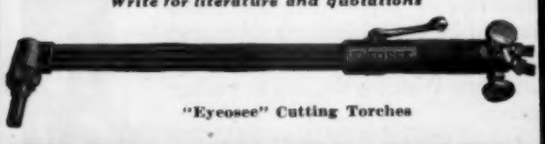
All Equipment Fully Guaranteed.
Quick Shipment and Low Prices.

KNOWLES ELECTROLYTIC PLANTS

for the production of hydrogen

Knowles Patented Cells are safe, simple, easy to install, automatic, low in first cost and maintenance, and in addition to flexibility of operation have the advantage of producing also a quantity of pure oxygen equal to 50 per cent of the hydrogen volume. All sizes up to 15,000 amperes. Total annual hydrogen capacity of plants now in operation, over one and one-half billion cubic feet. Our experience as American Manufacturers and Distributors enables us to recommend these plants unqualifiedly.

Write for literature and quotations



"Eyesee" Cutting Torches

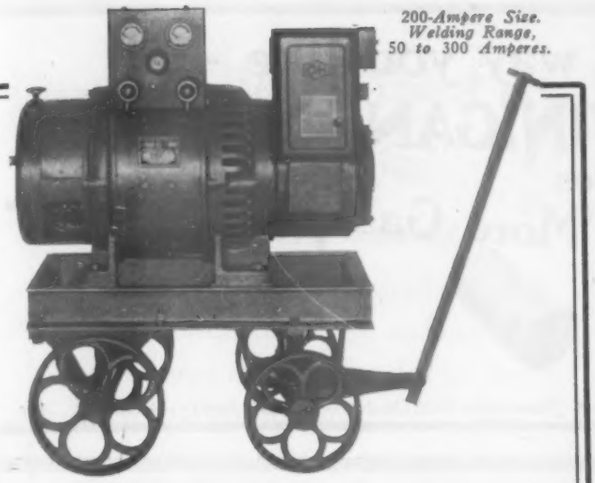
INTERNATIONAL OXYGEN COMPANY
Main Offices: Newark, N. J.
Branches: New York Pittsburgh Toledo Buffalo

American Welding Society
33 West 39th Street
New York, N. Y.

WHAT IS IT DOING?

WHO ARE ITS MEMBERS?

The Secretary has a copy of the Membership Directory for you. Write for it.



200-Ampere Size. Welding Range, 50 to 300 Amperes.

Here are the plain reasons why the

Hansen Arc Welder

will do things no other welder will do

1. No external stabilizer (an exclusive Hansen feature).
2. Extreme simplicity (self-excited; only one adjustment).
3. Remarkable stability of the arc.
4. Wide welding range (70 to 400 amps. on 300 amp. size).
5. High overall efficiency.
6. Unusual ease of operation.

Study these advantages, and you'll see why the HANSEN ***does*** deliver a better welding job.

NORTHWESTERN MFG. CO.
Clinton and Madison Sts., Milwaukee, Wis.

"Old Reliable" Willson Helmet No. 130

Carefully built for endurance, good ventilation, head comfort and genuine protection for the eyes. Equipped with Willson-Weld Glass,—Cuts out over 99% of the injurious rays. Here's your helmet. $10.20 each, f. o. b.

Willson Goggles, Inc., Reading, Pa.

SPOT

For Production Electric Welding Machines

SEAM

ARC

Gibb Welding Machines Company

Bay City, Michigan

New York—Philadelphia—Cleveland—Cincinnati—Detroit—Chicago—St. Louis—Los Angeles—Toronto—Montreal

Welding Rods for Every Purpose

WILSON

ELECTRIC ARC WELDING WIRE

WILLIAMS

Weldflo

WELDING WIRE

ELECTRIC and GAS WELDING WIRE

High-Grade Low-Priced

Guaranteed Analysis Absolute Uniformity

Immediate Shipment from Warehouse

Send for samples of the new Weldflo wire

WILLIAMS & COMPANY, INC.

WELDING SUPPLIES

925-935 Pennsylvania Avenue, Pittsburgh, Penna.

"Note the name Weldflo *Each rod the same"*

Representing: TORCHWELD EQUIPMENT CO.

Look at it any way you like —
SHAWINIGAN CARBIDE
gives
"More Gas per Pound"—

SHAWINIGAN PRODUCTS CORPORATION · NEW YORK · *Plants: Shawinigan Falls, Quebec · · Keokuk, Iowa · · Anniston, Ala.*

Electric Arc Welding Equipment

Transformer Arc Welders (A. C.)
Motor Generator Sets (Direct Current)
Gasoline Engine Generator Sets (D. C.)

A complete line of Electric Welding Accessories always carried on hand.
Electrodes—Holders—Masks—Handshields—Glasses—Cables, etc., etc.

ALLAN MANUFACTURING & WELDING CO., INC.
726 WASHINGTON STREET **BUFFALO, NEW YORK**

Sales Representatives Desired

HASKINS

Haskins H-5 Equipment
For Weld Grinding

Write for complete catalog today!

Quality that has no substitute

Back of every HASKINS Flexible Shaft Equipment sold is the HASKINS Trade Mark—a guarantee of quality construction, a pledge of dependability. No matter how severe the service, HASKINS cores and casings stand up under the strain, hour after hour, day in and day out. No costly repairs and replacements—no expensive delays.

Illustrated is the HASKINS H-5 Equipment, Bench Type. For grinding welds, for slotting before welding and for many other purposes this unit is ideal. It has a ¼ H. P. Motor, a Timken Roller-bearing Countershaft which affords four speed changes of 875, 1380, 2350 and 3500 R.P.M. Will more than pay for itself in a short time by cutting costs and speeding up production.

Write for full information today!

R. G. HASKINS CO.
Dependable Flexible Shaft Machinery.
4639 W. Fulton St., CHICAGO, ILL.
Branch Offices in Principal Cities.

Standard size pound box, $4.50.

Crown All-Metal Filler is a mineral composition that repairs cracked waterjackets, motorheads, waterpumps, porous castings, etc., by simply heating the casting to 400° heat and rubbing on the Crown All-Metal Filler, which will penetrate through to the underside and rust up and make a guaranteed, permanent repair. Can be made to flow up, down or sideways. Being gray in color, it blends with cast iron and steel, although it can be used on all metals.

SPECIAL FOR ELECTRIC WELDERS

Crown All-Metal Filler is the only compound that will make an electric weld on cast iron absolutely watertight. It penetrates through the smallest pin-hole where it is possible for water to leak out, and the filler will rust, which is necessary for a permanent repair.

Oldest Exclusive Makers of Aluminum Solders

TRADE MARK

CROWN CROWN CROWN

Crown Aluminum Solder (hard) has been tested by the Bureau of Standards, Washington, D. C., and shown to possess tensile strength of 14,500 pounds to the square inch. Not only is Crown the strongest made, but the easiest to handle and apply, and the saving of labor makes Crown a necessity to every welder.

Crown Aluminum Solder (soft) is recommended for sheet aluminum, particularly on body work and can be applied with ordinary soldering iron. After the solder is properly applied it can't be separated from the aluminum with aid of chisel and hammer. The soft is also recommended for cracks in castings.

Crown Iron Metallic Filler is the incomparable metal for filling scored cylinders. The special Crown acid is supplied free.

WRITE TODAY FOR NEW AND LARGER DISCOUNTS ON ALL CROWN SOLDERS

Crown Aluminum Solder Co. **881 E. 134th Street New York City**

Have You Heard About BORIUM ?

The Substitute for Diamonds

Borium is a manufactured product of uniform size, shape and composition and can be expected to give uniform performance.

Its hardness and resistance to abrasion is next to that of a diamond. Its cost is only 1/700 that of a diamond.

Write for Further Particulars

STOODY COMPANY

Welding Rods—Alloy Steel—Equipment

WHITTIER, CALIFORNIA

IDEAL FACE SHIELDS

Ideal Face Shields protect the head, chest and neck against direct and reflected rays. Easily adjusted and removed. Constructed of vulcanized fibre and aluminum, assuring durability and lightness. Hinged door allows quick inspection of work or interchange of glasses.

IDEAL WELDING GLOVE

The Ideal Glove for Electric and Acetylene Welders is made from Sheep Skin, which has been Subjected to an Asbestos Treatment and which makes it both heat resisting and fireproof.

IDEAL WELDING APRON

The Ideal Apron for Welders is made of leather which has been especially treated to stand the heat, and at the same time be very flexible and durable.

THE IDEAL FACE SHIELD CO.

468 N. Garfield Ave.,
COLUMBUS, OHIO

Dixon's Graphite Rods and Plates for Welding

Made in all diameters, lengths and sizes.

Small diameter rods are sold in 4, 6 and 8 inch lengths, the shorter the rod the less breakage in shipping.

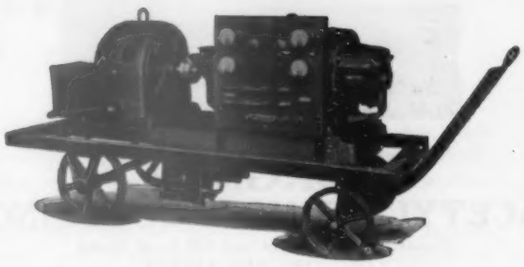
Also Dixon's Graphite Welding Putty. In 5 and 10 lb. cans.

Dept. 202A.

Joseph Dixon Crucible Co.

JERSEY CITY, N. J.

1827— ONE HUNDREDTH ANNIVERSARY —1927



More Welds at lower cost

Burke Variable Voltage Welder

In addition to the single operator type of welder we build a two-operator machine which is distinctively a Burke development.

Either operator can regulate for his own requirements without affecting the other and may use any proportion of the capacity of the welder as long as their total demands are not greater than the rated output of the machine.

The results are self evident—greater production, flexibility and lower cost per weld.

Bulletin No. 133 gives complete description and superior features. *Write for it.*

BURKE ELECTRIC COMPANY

ERIE, PA.

Service Sales Offices:

NEW YORK CHICAGO PHILADELPHIA PITTSBURGH
CLEVELAND DETROIT BUFFALO

Sales Agencies:

AKRON — Berthold Elec. & Eng. Co.
INDIANAPOLIS — W. C. Fletcher Co.
KANSAS CITY — W. T. Osborn
TROY, N. Y. — E. I. Van Doren
CINCINNATI — Underwood Elec. Co.
MINNEAPOLIS — H. C. Lemire

TORIT **PREHEATING TORCHES**

Compressed Air Type or Portable Hand-Pump Type

Kerosene Preheaters save Time and Gas—produce better work!

BULLETIN ON REQUEST

ST. PAUL WELDING & MFG. CO.

170 West Third Street SAINT PAUL, MINNESOTA

FLEXIBLE SHAFT GRINDERS

TYPE M 6 - ½ H. P.

Strand

FLEXIBLE SHAFTING

We build many Types and Sizes from 1/10 to 2 H. P. Thousands in use.

Send For Our Booklet B

Manufactured By

N. A. STRAND & CO.

CHICAGO

Factory and Office

5001 - 5009 No. Lincoln St.

Anti-Borax WELDING FLUX

"ANTI-BORAX"

Oxy-Acetylene Fluxes

are made for every metal and have EXCEPTIONAL merit.

BRAZ-CAST FLUX

For bronze welding of Cast Iron.

We also make the popular "E-Z" Welding Compound for forge welding.

Samples of any upon request.

Anti-Borax Compound Co., Ft. Wayne, Ind.

At your leisure inspect and test in your own office the Eye Protection and comfort our goggles give.

RESISTAL test pieces are free.

IMMUNITE positively keeps out all harmful rays.

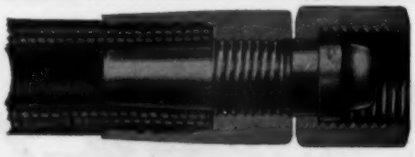
OKICUP—RIDO'DUST—SHALOCUP — TUFF lenses—INSULA WELDA. all meet the most rigid requirements of the U. S. Navy, Pennsylvania State Department of Labor, National Code, etc. The Underwriters' Label, too, certifies Safety.

No salesman can convince you as well as this Kit will.

Send for the Kit of samples "On Memo."

No obligation—glad to have you look.

STRAUSS & BUEGELEISEN, 26 Front St., Brooklyn, N. Y



NORGREN

ACETYLENE HOSE COUPLING

Standard 9/16x18, right and left hand thread

LONG LIFE AND SAFETY

List Price All Sizes, $1.00

Write for literature and discounts

CARL A. NORGREN CO.

1157 CALIFORNIA ST., DENVER, COLORADO

ROBERT E. KINKEAD

ARC WELDING SPECIALIST

CONSULTING ENGINEER

3030 Euclid Ave. CLEVELAND, OHIO

WELDING ROD HOLDER

FOR THE OXY ACETYLENE WELDER

$1.00

ALL STEEL WIRE BRUSHES

SEND $1.00 FOR 5 ASSORTED BRUSHES

Money refunded on return of goods, if not what you want.

WRITE FOR DEALERS' PRICES

C. SORENSEN, 18 E. 16th ST., CHICAGO

$4.50

UREEKA Metallic Electrode Holder

Permits the holding of electrode with tremendous pressure, but requires only very slight pressure to release. Perfect electrical contact between electrode and holder, with elimination of current losses and overheating. For 1/8" to ¼" diameter electrodes.

GREAT STRENGTH, LIGHT WEIGHT, AMPLE CURRENT CAPACITY. NO SPRINGS.

Saves time, current, rod and worry. Try it.

$10

VULCAN Carbon Electrode Holder

for all heavy duty carbon arc welding

Positively will not overheat. Light weight. Easy to manipulate. 200, 400 and 600 ampere sizes for ½", ¾" and 1" diameter Electrode.

DISTRIBUTORS WANTED

The Fibre-Metal Products Co.

Designers and Manufacturers since 1914 of Bower's Welding Helmets and Hand Shields

CHESTER, PENNA.

COULD YOUR PROBLEM BE ANSWERED by the SPOT WELDING of DISSIMILAR METALS?

THE success of the use of Elkonite Welding Electrodes in spot welding dissimilar metals and alloys has brought it to the attention of welding engineers the country over.

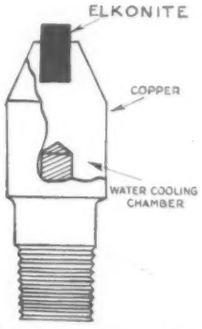


Fig. 1. Water cooled spot welding electrode showing Elkonite Insert. (Courtesy General Electric Co.)

The variable electrical and heat resistance of the different grades of Elkonite Welding Electrodes, plus their ability to hold their shape without mushrooming under red heat, heavy pressures and high currents are properties of immense value.

For this variable, relatively high resistance Elkonite as one electrode, with low resistance Elkonite or copper as the other, gives the balance necessary for even heating to welding temperature of metals of unequal heat and electrical conductivity, such as, for instance, copper with galvanized iron, or with nichrome.

METALS	ALUMINUM	ASCOLOY	BRASS	COPPER	GALVANIZED IRON	IRON	LEAD	MONEL	NICKEL	NICHROME	TIN PLATE	ZINC
ALUMINUM	•											
ASCOLOY		•		•	•	•		•	•	•	•	
BRASS			•	•	•	•		•	•	•	•	
COPPER		•	•	•	•	•		•	•	•	•	
GALVANIZED IRON		•	•	•	•	•		•	•	•	•	
IRON		•	•	•	•	•		•	•	•	•	
LEAD							•					
MONEL		•	•	•	•	•		•	•	•	•	
NICKEL		•	•	•	•	•		•	•	•	•	
NICHROME		•	•	•	•	•		•	•	•	•	
TIN PLATE		•	•	•	•	•		•	•	•	•	
ZINC												•

Fig. 2. Combinations of metals successfully welded with Elkonite. (Courtesy General Electric Co.)

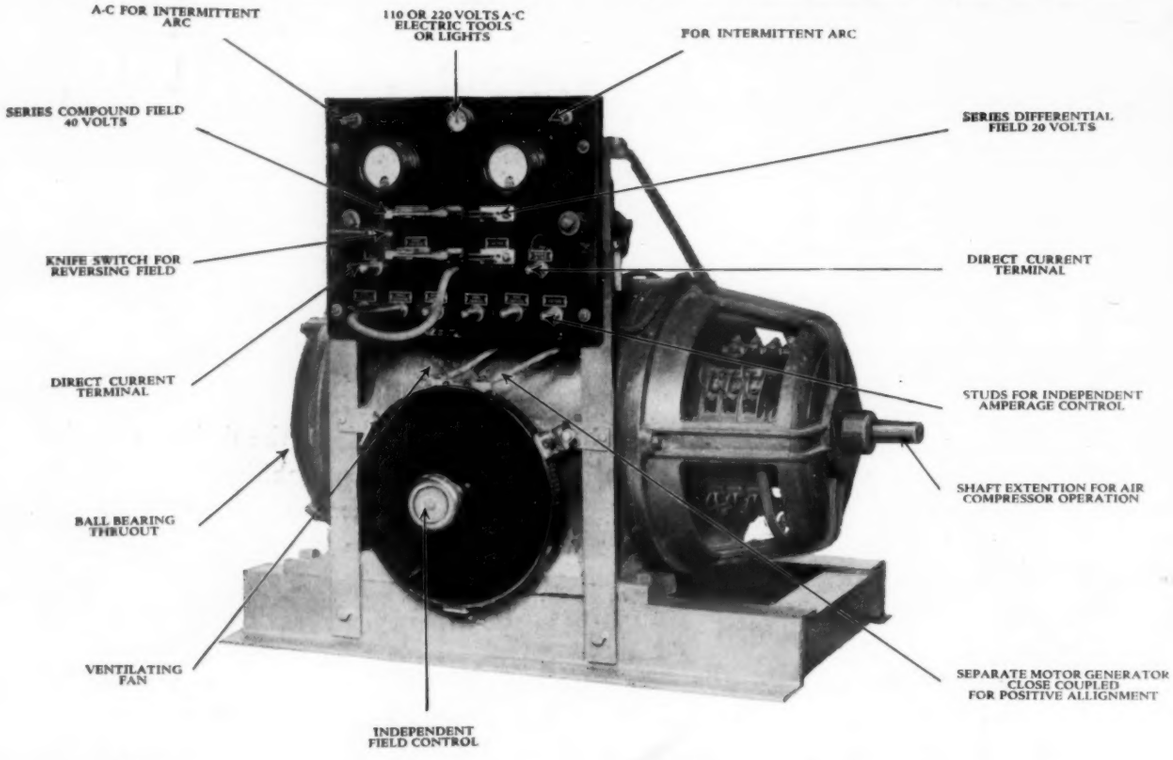
This is but one phase of the contribution that Elkonite has made to resistance welding. In flash, cross-wire, projection welding, electrical upsetting of rivets, as well as in spot welding non-ferrous and heavy gauge ferrous metals Elkonite, by eliminating lost time and production due to constant redressing, and shrinkage loss, is showing new economies and production possibilities in many industries.

Our engineering staff will gladly co-operate in any resistance welding problem.

ELKON WORKS Inc.
Subsidiary of P. R. Mallory & Co. Inc.
Weehawken, N. J.

Exclusive licensees under General Electric Co. patents dated May 28, 1925 and Sept. 1, 1925. Other patents pending to Elkon Works.

DUALARC WELDERS


A-C FOR INTERMITTENT ARC
110 OR 220 VOLTS A-C ELECTRIC TOOLS OR LIGHTS
FOR INTERMITTENT ARC
SERIES COMPOUND FIELD 40 VOLTS
SERIES DIFFERENTIAL FIELD 20 VOLTS
KNIFE SWITCH FOR REVERSING FIELD
DIRECT CURRENT TERMINAL
DIRECT CURRENT TERMINAL
STUDS FOR INDEPENDENT AMPERAGE CONTROL
SHAFT EXTENTION FOR AIR COMPRESSOR OPERATION
BALL BEARING THRUOUT
VENTILATING FAN
SEPARATE MOTOR GENERATOR CLOSE COUPLED FOR POSITIVE ALLIGNMENT
INDEPENDENT FIELD CONTROL

Years Ahead of Their Time!

From an engineering standpoint the DUALARC Welder is different and thoroughly original. It is years ahead of its time and has many outstanding and exclusive advantages.

DUALARC Welders will operate as either compound or differentially wound generators. This is an exclusive feature that gives maximum efficiency using either the metallic or carbon arc.

DUALARC Welders can supply either Alternating Current or Direct Current. The Alternating Current can be used for the operation of electric drills, grinders, drop lights and for intermittent arc welding.

DUALARC Welders have a separate control of voltage and amperage giving any welding heat desired. This feature provides the widest range of flexibility and Heat Control ever realized in Direct Current Welders.

DUALARC Welders have these advantages and many more combined to give maximum flexibility and service for welding.

Write for our new Alternating Current Welder and Direct Current Welder folders. Just off the press.

There are a few desirable territories open in the South and West.

Electric Arc Cutting & Welding Company

Factory
152-158 Jelliff Avenue
NEWARK, NEW JERSEY

Sales Office
1202-1208 Maccabee Building
DETROIT, MICHIGAN